AN INVESTIGATION OF PERFORMANCE-BASED ASSESSMENT IN SCIENCE IN SAUDI PRIMARY SCHOOLS

By

Abdullah Saleh Al-Sadaawi

Doctor of Philosophy

School of Education

Faculty of Human Development

Victoria University

Melbourne-Australia

Supervisors

Professor Maureen Ryan

Dr Anthony Watt

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DECLERATION OF ORIGINALITY

I Abdullah Saleh ALSadaawi, declare that the PhD thesis entitled *An investigation of performance-based assessment in science in Saudi primary schools* is no more than 100,000 words in length, exclusive of tables, figures, appendices, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

Signature: Date

ABSTRACT

This study was undertaken to develop a performance-based assessment approach in science learning and to investigate its effects on students' achievement and attitudes toward science as well as the readiness of Saudi primary schools in relation to its implementation. The approach links the assessment methods to cognitive and social constructivist learning theories and science curriculum reforms. Twelve science classes comprising 289 primary school students and six teachers in the city of Riyadh formed the sample for the study. Six classes were randomly selected and were instructed using a performance-based assessment approach. A second cohort of six classes was instructed traditionally as control groups. The same teachers directed both experimental and control groups for nine weeks. Data were collected by different tools involving tests, interviews, and questionnaires. Science tests and Students' Attitudes toward Science Survey were administered as pre- and post-tests to evaluate the control and experimental groups. The Teacher Performance Assessment Questionnaire (TPAQ) was applied as pre- and post-tests for the science teachers' responses to the program. Interviews involving all six teachers and 12 randomly-selected students were conducted at the end of the nine week period.

Both quantitative and qualitative analyses were applied to the collected data. Quantitative analysis involved both descriptive and inferential analyses using means, standard deviations, and parametric tests; whilst QRS Nvivo was used as the coding method for qualitative analyses. The results of quantitative analysis showed that students in the experimental group had significantly higher scores in the science post-test than the students in the control groups. There was also a significant

attitudinal difference towards science between the experimental and control groups in favour of the experimental group. The performance-based assessment procedures were found capable of predicting approximately 23 per cent of variation in the students' final science test scores.

Qualitative analysis' results from the teachers' data indicated that they evaluated performance-based assessment approach highly: it gave students the opportunity to be active, and interactive, and greater responsibility toward learning. In addition, the teachers responded well to the experimental program and reported they had received professional development: formulating open ended questions, administering groups, designing experiments and using formative assessments. They considered changes to classroom practices to incorporate these factors from performance-based assessment and give students more opportunity for control over their learning. The result of the paired sample t-test showed no significant improvement on teachers' assessment standards as measured by the TPAQ, whereas the effect size indicated a large change in teachers' performance. Teachers reported some disadvantages of performance-based assessment. Teachers reported that it was time consuming, required extra work, was difficult to assess, and did not fit into the current Saudi school environment.

Qualitative analysis of the students' data showed that students from the experimental groups found the performance assessment approach an opportunity for greater control over learning processes, to actively participate in the science class, and importantly, group work encouraged them to work cooperatively. Students reported performance-based assessment was useful, and this study's results confirmed that the processes undertaken supported self-efficacy development.

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DEDICATION

I would like to dedicate this dissertation to my former manager Dr Ali Alhakami who has been my inspiration in my professional growth. The last word I heard from him before heading to my study was “Don’t attempt to undertake a descriptive study, we already know our weaknesses, try to suggest an innovative method that we can struggle with to improve our educational outcomes”. I dedicate this work to him and all educators who are looking to reform our educational system in the hope that it can give them hints to the direction that we should think in order to obtain an authentic reform not just in science but in all other subjects.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Contemporary development in cognitive and constructivist theory changes the researcher’s perspective regarding acquisition of knowledge and competencies. In this perspective, meaningful learning is reflective, constructive, and self-regulated; learners are seen not as mere receivers of information but as creators of their own unique knowledge structures (Elshout-Mohr, Oostdam, & Overmaat, 2002; Liu, 2000). In this way, learners can achieve a more meaningful goal in which acquisition of knowledge, skills, and attitudes enable them to act effectively, expertly, and professionally under a teacher’s guiding role (Freedman & Lee, 1998). Assessment theory and practice are evolving to reflect these complexities, moving away from a narrow focus on simple tests and scoring that previously dominated teaching (Cumming & Maxwell, 1999; Howell, Brocato, Patterson, & Bridges, 1999). In the information age, Liu (2000) asserts, students do not need to acquire a vast amount of information, typically the focus of traditional tests, but rather the ability to think, and organise that information for specific purposes. Thus, achievement needs to be considered as a qualitative change in a person’s conceptions, not simply the amount of knowledge that a person possesses. It is no longer enough to count the number of correct answers on a test.

For two decades researchers have criticised traditional tests such as multiple-choice, fill-in-the-blank, and true or false questions (Akerson, Morrison, & McDuffie, 2002; Herman, Aschbacher, & Winters, 1992; Higuchi, 1993; Pate, Homestead, &

McGinnis, 1993). Traditional techniques do not prove effective for the expanded concept of learning that requires students to demonstrate higher-level thinking skills (Sweeny, 1996). Linn, Baker, and Dunbar (1991) emphasise that traditional tests evaluate a limited number of cognitive functions and skills related only to memory, and students' ability to recall material learned out of context. Moreover, for purposes of accountability, teachers tend to tailor their instructions to students in imitation of multiple-choice questions (Baker, 1996; Kane, Khattri, Reeve, & Adamson, 1997), thus encouraging students to focus only on the options before them (Herman, 1997). Therefore, "teaching to the test" has become a common practice in schools (Bowers, 1989; Izard, 2004; Resnick, 1996), narrowing students' potential to low-level skills, and distorting the curricula: for example, neglecting science, and social studies in favour of reading, and mathematics (Baker, 1996; Shepard et al., 1996). In addition, science educators claim that traditional tests cannot sufficiently evaluate students' ability to design and undertake experiments or assess their understanding of scientific concepts (Whitman, Klagholz, Schechter, Doolan, & Marganoff, 1998). In regard to this issue Hein and Price (1994) state:

> Assessing science through paper-and-pencil tests is akin to assessing a basketball player's skills by giving a written test. We may find out what someone knows about basketball, but we won't know how well that person plays the game (quoted in Whitman et al., 1998, p. 51).

To assess students on scientific reasoning and understanding rather than simply measuring discrete knowledge, critical assessment methods were developed, with a strong preference emerging for performance-based assessment (Morrison, McDuffie, & Akerson, 2003; Scott, 2002). Researchers such as Hakel (1998) and

Howell, Brocato, Patterson, and Bridges (1999) identify performance-based assessment as the focus for education reforms in assessment, curriculum and instruction. The proponents for this type of assessment (Akerson et al., 2002; Guy & Wilcox, 2000; Perlman, 2003; Shavelson, Ruiz-Primo, & Wiley, 1999; Shepard & Others, 1996; Solano-Flores, 1997; Wiggins, 1998) argue that a performance-based assessment methodology provides students with meaningful paths to demonstrate their knowledge. The technique also improves student skills by bringing into play complex functions of cognitive processing that require a higher level of thinking for problem-solving, or the development of options when an individual confronts a new situation.

Since performance-based assessment occurs over a period of time, it provides an opportunity for students to individually achieve the highest level of learning (Baker, 1996). Unlike the memory-based traditional testing procedures, performance-based assessment is *authentic* assessment, because it involves the performance of tasks that are valued in their own right, it is situated in a real world context, and it can mirror actual tasks implemented by professionals (Jorgensen, 1994; Linn et al., 1991; Mabry, 1999). These characteristics of performance-based assessment allow students to engage with meaningful problems that foster significant educational experiences (Garbus, 2000; Kulieke et al., 1990; Linn et al., 1991).

In the classroom, performance-based assessment has value for students and teachers. For students, performance assessment provides a realistic approach to science, reinforces the inquiry skills of science that facilitate the art of language and the use of mathematics, and assesses self-progress (Pico II, 1999). For teachers, the methodology provides timely information on the learning needs of their students, and thus the teaching methods they employ (Corcoran, Dershimer, & Tichenor, 2004).

Performance assessment is therefore an appropriate strategy for assessing students' concepts and skills in science, and it prepares students for a productive future within a technologically complex world. The methodology also fits the nature of science, that is, the study of active structures, and frequently changing natural phenomena (Ainley, Hidi, & Berndorff, 2002; Atkin, Black, & Coffey, 2001; Collins, 1997; Guy & Wilcox, 2000; Shavelson, 1994). In addition, Atkin, Black, and Coffey (2001) claim that the current goals for science in educational standards reform present a significant shift to performance assessment. This is due to the fact that standards reform presents science as a subject where students are actively involved in science rather than reactive reading or listening.

Empirical studies of the impact of performance-based assessment show positive effects in the quality of students' learning and attitudes. Baxter and Glaser (1996) found that performance-based assessment not only supports the development of thinking and reasoning in the classroom, but also provides teachers with feedback that can be used to improve the classroom environment. Similarly, Biondi (2001) found that performance-based assessment is a valid, equitable measurement of student progress. Through performance assessment strategies, students become more focused in their work, are able to reflect on their learning activities and abilities, and develop a higher level of vocabulary through group conferences and self-assessments. After studying the effective performance-based assessment for evaluating fifth- and sixth- grade student science achievements, Parker and Gerber (2002) conclude that performance-based assessment is effective in measuring the knowledge and skills of science students.

Many educationalists however propose that performance-based assessment should be considered not merely as a process for assessing students' understanding, but also as a learning process; one that teaches students concepts and requires them to explain and communicate their interpretations of the information, and their methodology for solving problems (Liu, 2000 ; Morrison, McDuffie, & Akerson, 2002). Rudner and Boston (1994) suggest that with performance assessment methodologies, instructional objectives in science should be redefined to include more practical applications and more emphasis on synthesis and integration of content and skills. Therefore, a considerable change in instructional procedures as well as in science curricula must take place to align with theoretical conceptions that underline the new assessment method. With performance assessment, teacher-centered instruction practices must give way to more student-centered techniques that allow students to become engaged actively in the skills they need for their roles (Pfeifer, 2002). In this situation, performance-based assessment can change classroom learning structures in which students merely listen and absorb information to those in which students actively participate (Gopinath, 1999), working together or separately (Haury, 1993). Further, students in this learning experience can assess their own progress and therefore be more responsible for their own learning (Andrade, 2000).

Educational researchers (Graham, 2005; Graue, 1993; Shepard, 1995) assert that calls for assessment-driven reform require training and support for teachers. Shepard (1995) found that well-intentioned efforts to assist students to improve can be misdirected if teachers do not understand the philosophical and conceptual bases of the intended curricula goals. For current assessment reform to be efficient, particularly assessment based reform, teachers' expectations for their students' performances, and for teaching styles must be transformed (Kane et al., 1997). Graue (1993) states that if implementing performance assessment is viewed as a learning opportunity for teachers, then they should participate in designing the forms and functions of assessment. However, she asserts that teachers cannot do this without training and preparation to facilitate either the instructional or assessment reforms.

Science education is a national issue in many countries, and considerable educational reform resources are dedicated to improving science education, especially assessment practices (Chang & Chiu, 2005; Gott & Duggan, 2002; Liu, 2000). Unfortunately, Saudi Arabia has not yet provided sufficient resources to undertake significant education reform, particularly in this area of primary-school science. Classroom assessment practices have remained unchanged for a considerable amount of time. Saudi teaching styles, based on behaviourist learning, display limited knowledge of contemporary theories in pedagogy and assessment. These factors contribute to the typical Saudi approach to science instruction; a shallow coverage of many topics delivered in a ritualised manner that fails to engage students or offer challenges to pursue further learning. BouJaoude (2003) claims that science teaching in the Arab world (including Saudi Arabia) suffers from an overemphasis on teacher-centered approaches and pedagogies that involve memorising, and neglects the development of critical thinking, problem-solving, and inquiry skills. As a result, recent results of Trends in International Mathematics and Science Study (TIMSS,2003) show that, compared to their peers in 46 other countries, Saudi students rank at the lower end of performance in science test results (IEA, 2003). It follows that the Saudi educational system is not focused on innovation, despite recent Saudi policy reforms in students' assessment procedures and therefore the country cannot pursue the reform that is so desperately needed.

1.1.1 Statement of the Problem

Performance-based assessment can be a valuable tool for education reform (Resnick & Resnick, 1992), and therefore has attracted considerable attention from researchers and educational organisations over the last two decades. During this time, several forms of assessment methodology were applied in many countries, including Saudi Arabia. In 1999 traditional assessment practices in Saudi were replaced by continuous assessment, a form of alternative assessment, for the first three grades of primary schools. Continuous assessment modifications to the education system resulted from a bylaw imposed by the Higher Committee for Education Policy. However, the new assessment methodology was applied out of its original educational context, and after only a short trial period involving few schools. Preferably, a wider study could have been undertaken, as part of broader education reforms involving curricula and instruction.

Upon mandate from the bylaw, continuous assessment methodology was implemented in all primary schools through distribution of teacher guidelines relating to assessment standards for each subject. Although the intention of the assessment bylaw was to promote the use of a formative assessment process; in actuality the policy resulted in an unchanged focus on the use of traditional tests and checklists, that is, summative assessment remained. Teachers were instructed in the guidelines “to assess their students . . . (with) grades of pass or fail based on their performance on weekly assignments” (Alabdelwahab, 2002, p 15), however, teachers had difficulty assessing students as directed. The authorities responded by issuing further explanatory material containing skills and knowledge levels required for a student’s promotion to the next grade. Unfortunately, this did little to promote the underlying principle of formative assessment application. In relation to this matter, Al-Sadan (2000) stated:

> Regarding the element of continuous assessment, it should be noted that the element most commonly favoured by teachers is the written test…. Thus, it would appear that assessment methods may not be conducive to encouraging a range of work which would form pupils’ minds effectively (p. 154).

The assessment bylaw for Saudi primary schools focused on continuous assessment practices; however, implementation was attempted without teacher training programs to introduce the principles behind the new form of assessment, and without instructions in preferred applications. Research shows that a lack of appropriate consideration of educational reform and in conjunction with an arguably incomplete and partial attempt at such reform caused serious difficulties for teachers, staff, students, and their parents. Teachers were unfamiliar with the concept, unable to use assessment as it was proposed, and could not revert to the traditional assessment methodology. The outcome was that inappropriate composite methods of assessment were applied in primary schools. Further, results indicate that, rather than instigating progressive assessment methodology, the bylaw significantly hampered education reform development. The results of a missed opportunity for students is described by Al-Sadan (2000):

> The regulation and procedures of assessment in Saudi schools omit any reference to individual or group work. The educational system is geared towards examinations considered to be the crucial gateway to personal advancement. The system has been described as a 'killer of pupils'. Teachers and pupils focus on only one objective: how many pupils will pass? (p. 154).

Consequently, students continue to view science classes only as means to pass exams; therefore they retain knowledge of science content for only a short time for exam purposes (Meshaigeh, 1989, cited in Al-Abdulkareem, 2004).

A further argument is proposed: that although the continuous assessment methodology was applied to the lower grades of Saudi primary schools as a response to current international practices in assessment reform, a fundamental lack of preparation hampered its implementation. In addition, the concept of *continuous assessment* is ambiguous; there is no comprehensive and well-regarded definition for the term, and in the Saudi example there was no comprehensive documentation detailing principles, standards or methodologies, nor was a training program offered.

Few studies, if any, have presented insights on improving Saudi classroom assessment practices in general, and the science classroom in particular. Importantly, there is a lack of extant informed argument for Saudi educational reform when compared to social demands voiced in the media. Teacher assessment guides remain focused on summative assessment rather than formative assessment, which have prompted concerned parents to call for the pre-1999 assessment methods to be reestablished. In this complex environment, this study provides a clearer approach to education reform with the use of performance-based assessment which has been proposed in the assessment literature for science curriculum in addition to many other subject areas (e.g., Baker, 2004; Shavelson, 1994; Shepard, 2000b; Wiggins, 1998). Further, a clear approach to education reform may assist in relieving compounding issues brought about by the unsuccessful continuous assessment program.

1.1.2 Purpose of the study

The purpose of this study is to develop a performance assessment approach based on constructivist learning concepts, with learning and instruction content focusing on inquiry and problem-solving in the cooperative science classroom. An objective is to examine the effects of this study’s approach compared to traditional testing methods in students’ learning outcomes and attitudes toward science in grade six science classes in Saudi primary schools. In addition, this study investigated the readiness of Saudi primary schools for implementing the approach developed by the researcher.

1.1.3 Significance of the research

A majority of educators accept that performance-based assessment is an effective approach in developing an integrated and successful educational system, not only because it emphasises higher-order thinking skills for students, but also because it improves teaching skills and supports curriculum reform (Akerson et al., 2002; Clark, 2004; Moskal, 2003a; Parker & Gerber, 2002; Shavelson et al., 1999). Further, performance-based assessment is a crucial tool for ongoing improvement of elementary science, as traditional assessment has focused on cognitive areas that, whilst simpler in measuring acquired knowledge, overlook science skills that require observing, inferring and experimenting (Century, 2002; Haury, 1993). As many countries, including United States, Australia, and Saudi Arabia, view students' achievement in science as a national goal, the implementation of performance-based assessment which can significantly improve science learning outcomes has increased significantly. Saudi Arabia, as a participant of the Trends in International Mathematics and Science Study (TIMSS), continues to develop its curricula, and assessment practices, particularly in primary schools.

In addition, as concepts relating to alternative assessment are still unclear in Saudi education, there is an urgent need for teachers and the community at large to be exposed to a practical model of assessment. As this study precedes Saudi Arabia's implementation of continuous assessment in later primary school classes, the model presented in this study is useful in providing wide awareness and practice of performance-based assessment. Further, as various models of performance-based assessment continue to be introduced internationally, Saudi education researchers observe implementation, mindful of application possibilities for Saudi primary schools and outcomes for learning and teaching (Al-Dossary, 2000).

An objective of this study is to examine issues relating to a professional development program to increase teachers' assessment skills. Carr et al.(2003)

propose this as a crucial point. After reviewing a considerable number of empirical studies and meta-analyses regarding the effects of curricula and assessment options on pedagogical approaches and educational outcomes, they found that professional development was “the aspect of teachers’ assessment skills and procedures that is most in need of further research and development” (p. 92).

This study is built on existing knowledge-bases related to the techniques associated with performance-based assessment on primary school science. In addition, it provides an under explored cultural context regarding the introduction of both curriculum and teaching associated with performance assessment procedures within Saudi primary school system. In fact, there is a lack of research in the Saudi environment that addresses performance assessment, whether for summative or formative purposes. The researcher could not find any study undertaken in the Saudi environment that based on constructivist principles that linked assessment to curriculum and teaching. So, it could be claimed that this research is the first study in Saudi Arabia based upon integrated experimental project focusing on the interactive relationship between assessment, curriculum and teaching, and taking into account attitudes and professional development factors, in conjunction with other school factors such as facilities and school community.

In terms of the effects of performance-based assessment on science learning and teaching, this study aims to contribute assessment knowledge in the context of the Arab culture and its school environment. These aspects of research have been neglected in the assessment literature (Black & William, 1998b; Carr et al., 2003).

1.2 Definition of terms

1.2.1 Performance-based assessment:

The Office of Technology Assessment of the U.S. Congress (1992) defines performance-based assessment as “a type of assessment that requires a student to create an answer or a product that demonstrates his or her knowledge or skills” (cited by Elliott & Fuchs, 1997, p. 6). In this study the terms performance-based assessment, performance assessment and alternative assessment are interchangeable because they have similar meanings (Liu, 2000; Pico II, 1999). The term performance-based assessment is usually chosen by researchers because it is more revealing than authentic and more descriptive than alternative (Pico II, 1999). For the purpose of this study performance-based assessment (or performance assessment) is defined as any type of assessment that goes beyond the use of traditional tests.

1.2.2 Traditional assessment:

Traditional assessment is defined in this study as tests that are given at a particular point in time to sample student knowledge (Hancock, 1994). Century (2002) defines traditional assessment as “items that are responded to and scored in exactly the same way for all students” (p. 7). It has a set value for all work done by students. It has many forms of application, such as true/false, multiple-choice, matching, and fill-in-the-gaps.

1.2.3 Attitudes:

Salta and Tzougraki (2004) report that most definitions agree that attitudes refer to the tendency to think, feel, or act positively or negatively toward objects in the environment. This thesis conforms to that view.

1.2.4 Student outcomes:

Student outcomes, as used in this study, are defined as specific knowledge and skills that students master as a result of curricular, instructional, *(and assessment)* practices (Vogler, 2000, p. 11).

1.2.5 Primary school:

Primary school refers to that portion of the Saudi school system involving grades one through six.

1.3 Limitations

For religious and cultural reasons that separate schools according to gender and prohibit males access to girls' schools, the study is limited to male primary science students in grade six in Saudi public schools, and their science teachers. It is also limited to performance-based assessment in science classrooms. Using performance-based assessment for accountability as a high-stakes assessment (that is, sole measure testing), or on a large scale, or direct issues, are not in the scope of this study.

1.4 Organising the study

Within a theoretical framework of cognitive and constructivist theory, this thesis develops a performance-based assessment approach in which instructional procedures and learning processes are integrated with assessment within constructivist environments in primary school science. It seeks to offer a model for educational reform in Saudi schools, based on related literature and international educational reforms. As I will argue, the regulatory route to science education reform can deliver a profound change in educational processes if implementation is appropriately planned, resourced and executed.

This thesis is divided into eight chapters. This first chapter introduces the theoretical framework and the study content itself; it sets out the purpose of the study and comments on the significance of the research and the limitations of the study.

The second chapter contains a review of the important literature on reform curricula and assessment in science. A theoretical assessment framework is presented which links science assessment and curricula to contemporary learning concepts. This framework is used as a guide for the design and implementation of the study project.

The third chapter considers the professional development of science teachers as an issue in the successful implementation of performance-based assessment. This chapter includes practical studies and reports to illustrate applications of principles relating to performance assessment.

Chapter four presents an overview of the educational system in Saudi Arabia. It includes a profile of the country, notes the main characteristics of its educational system, and options and constraints in the development of education delivery in the country. The chapter then focuses on the three elements; curricula, assessment, and teaching; and where possible, explores these elements within a primary school science environment.

Chapter five outlines the methodology of the study, including research design, sample, description of the study project, and the procedures used. Chapter six contains data analysis, including quantitative and qualitative analyses. The findings are prepared separately for each research question and clarified by tables, graphs and charts. Chapter seven discusses the study findings within the theoretical framework of the literature and through this researcher's perspective.

Chapter eight summarises the study's procedures and findings, provides conclusions and offers recommendations based on the findings.

CHAPTER 2: LITERATURE REVIEW

In this chapter, an adapted theoretical framework in classroom performance assessment is presented, together with consideration of the complexity of the adaptation and integration of learning theory, science curriculum reform and performance-based assessment. Literature on the development of curricula and assessment science precedes the body of the chapter, and a description of performance assessment is also discussed.

2.1 Primary science curricula and assessment antecedents

Performance-based assessment method is integral to the primary school science curriculum reform movement. From the mid-twentieth century, school science curricula witnessed dramatic change which gave momentum to developing the concept of performance assessment. However, as Kind (1996) indicates, it is difficult to link the notions of performance assessment to specific theories or a particular movement. Performance assessment in science is a complicated concept, where many theories and ideas interact and provide a basis for new ideas about learning and assessment in school science. In this section, critical aspects in the development of science curricula are discussed. Relationships are drawn between curriculum issues and the parallel development of assessment practices in the science classroom. Finally, the interrelationships of curricula and assessment practices are considered as influences on the notions of learning and assessing science, which require performance-based assessment.

2.1.1 Science curriculum reforms

Over the last 60 years, a majority of researchers (Kind, 1996; Orpwood, 2001; Soyibo & Beaumont-Walters, 2000; Tamir, 1999) classified science curriculum reforms into two phases. The first phase was a *reform period* or a *process-oriented approach* which occurred in the 1960s and 1970s, whereas descriptors for the second phase were the *alternative approach* or a *knowledge-based approach* (Kind, 1996; Tamir, 1999). In the process-oriented approach, science and curriculum theorists (e.g., Hirst, 1974; Shulman & Tamir, 1973) were concerned about the nature of disciplinary knowledge and the methods by which it is obtained, so for each discipline, including science, they determined conceptual and procedural structures which unequally signified the knowledge of that discipline (Tamir, 1999). Students using this science curricula were expected to learn the concepts and theories of science, and also to acquire an understanding of how science functions as a discipline, together with the skills associated with scientific investigation (Orpwood, 2001). Linn (1997) claims that the focus in this period on student understanding was brought about by interaction between developmental psychologists and natural scientists. In his developmental theory, Piaget (1971) argues that students simply could not reason abstractly until they had considerable concrete experience. Kind (1996) finds that the developmental cognitive stages in Piaget's theory match scientific processes; classifying, and measuring, for example, were related to the concrete operational stage, and complex problem solving to the formal operational stage.

Positive attitudes towards processes can be found, also, in Dewey's theory and his term *Learning by doing* (Kind, 1996). Dewey (1963) assumes all principles are abstract and they can only be concrete from their application. Everything depends upon the interpretation given them as they are put into practice in the school and the home. Similarly, Gagné (1965) argues that scientific concepts and principles are learned only through the operation of science processes or discovery. He illustrated a set of practical processes that link with the processes of learning that in turn can be transferred through scientific content domains, such as observing, classifying, describing, communicating, drawing conclusions, making operational definitions, formulating hypotheses, and conducting experiments (Kind, 1996).

This approach has been included in many science curricula and has been important in describing the methodology of learning science in schools (Kind, 1996). This conceptual approach has been applied in a number of science curriculum reforms, such as the Nuffield science project in England, and *Science - A Processes Approach* (SAPA) in the USA, which was designed and guided by Robert Gagne for elementary schools. There are three assumptions underlying the SAPA project. The first is that science can be taught in a manner considered faithful to the intellectual approach; that is, applied science rather than factual science; secondly, science should be *hands-on* scientific inquiry; and the last assumption is that teaching methods for science consider empirical findings of developmental psychology theory (Lawlor, n.d.).

This approach however was criticised even from its early development (Zuzovsky, 1999), because it emphasises separate and strict cognitive processes and neglects social and philosophical aspects (Kind, 1996; Linn, 1997). Further, compared with other teaching methodologies, the performance of students exposed to laboratory learning was limited (Hodson, 1990; Stake & Raizen, 2002). In England, for example, where great emphasis was placed on science curriculum processes, the results of a 1978 survey of science students in primary schools shows that the progress of science teaching was disappointing (Miller & Osborne, 1998). An important factor, as Orpwood (2001) reports, was "the failure of assessment in school science to match the changes in direction adapted by the curriculum" (p.139). Gagne modified his approach to a position where process skills were considered more open and flexible (Kind, 1996).

An alternative approach emerged in the 1980s, based on constructivist concepts of science and learning, that "all knowledge is seen as invented conceptions that fit into, rather than match exactly, the external ontological world" (Kind, 1996, p. 24). It was argued that learners make sense of the world by balancing alternatives, classifying data, building on their observations, and in general applying a process of knowledge construction, and at the same time taking into account society, and the complex relationships among science and technology (Linn, 1997; Orpwood, 2001). Hodson (1998) argues that:

> Each student processes a unique personal framework of understanding, in which experiences, emotions, values, sense of self and social identity play a crucial mediating role, determining what is regarded as significant and when/how it is utilized (p. 112).

The main features of this approach were determined by Kind (1996), the learning processes became less important, and are considered as pedagogic means rather than ends, and attention has been paid to develop useful personal knowledge by engaging students' hands and minds. The researcher added that the teacher's role becomes to teach about science as an investigation which includes much more than just controlling variables and conducting fair tests.

The concepts of the alternative approach however, spread, and were discussed deeply through a body of literature which described the development, and rationale for the many versions of this new approach (Bybee, 1991; Hodson & Hodson, 1998; Meinhard, 1992). Thus various terms have emerged, such as *authentic school science* (Bybee, 1991; Hodson, 1992; Miller & Singleton, 1997; Roth, 1995), *doing science* (Hodson, 1998), and *doing good science* (Jorgenson, Cleveland, & Vanosdall, 2004). *Doing science*, for instance, has moved away from the rigidity of the scientific method to a holistic approach where activities meld. Recently, social constructivist perspectives and active learning are emphasised, where there are opportunities for students to undertake scientific investigation (Hodson, 2003). However, current characteristics of science curricula are presented later in the second part of the theoretical framework.

2.1.2 Assessment method and curriculum reform

As described, school science curricula have undergone dramatic changes over the last 60 years and assessment methodologies have changed in parallel. A significant paradigm change in science curricula therefore is accompanied by a similar change in an assessment paradigm to monitor skills and knowledge students have acquired through the new curricula. In fact, as Orpwood (2001) argues, such reform had not been made in science assessment particularly during the first movement of science curriculum reform in the 1960s and 1970s.

In a review of eight curriculum revolutions including the 1960s reform in the United States, Stake and Raizen (1997) report that "the innovations we studied have been uninterested in direct methods of improving such test scores" (p. 131). Orpwood (2001) asserts:

> It appears that the goals that formed the essence of the science curriculum revolution of the 1960s are still not being assessed with the same degree of attention as those that focus on simple recall of scientific information (p. 144).

Orpwood (2001) offers four reasons for this; first, the technology to assess students' abilities regarding science investigation was not available. Secondly, in the advent of performance-based assessment, psychometricians were not supportive of new forms of assessment after significant success in measurements using objective tests. The third reason is public credibility; parents, universities and other stakeholders preferred traditional assessment. The final reason was teachers' reluctance to develop their professional skills, and a preference for following university methodologies then current.

Accordingly, delays occurred in realisation of paradigm shifts in assessment methodologies to match the shifts in science curriculum reform of the 1960s and 1970s. This reticence to adopt assessment reform continued as a barrier to alternative assessment methodologies in later years. Of particular concern for educators was the psychometricians' validation and reliability methodologies for alternative assessment forms. Messick (1994) asserts that performance assessment must by evaluated by the same psychometric criteria as other types of traditional assessment. After they made the meta-analysis on a number of studies regarding the reliability or generalisability , Jiang, Smith and Nichols (1997) conclude that there are considerable differences between performance assessment and multiple–choice items in terms of measure reliability or generalisability coefficients. The proportion of variance to estimates of error in the measurement procedure is affected by the difficulty and occasion that are inherent in the construction of performance assessment. Performance assessment allows multiple correct solutions are unlikely to be equally difficult, and requires more time to answer than multiple-choice items, because performance assessment has more connections with instruction and is sometimes used as instructional activity. Therefore, Resnick (1996) argues that new psychometric criteria, rather than those applied to traditional assessment, should be developed to suit a new assessment. Performance assessment, the researcher continues, differs from traditional tests, firstly by being integrated within the educational system rather than being an external monitor, and secondly, performance assessment sets standards for students and teachers.

Early science curriculum reforms were unsuccessful partially through neglect of the assessment aspect, and multiple-choice tests for school accountability were widely used to counteract this effect. Educators consider this trend had an excessive influence on teaching and learning in the science classroom (Kane et al., 1997). Science teachers, facing demands of high performance of students, modified teaching styles, thus *teaching to the test* dominated. However, multiple-choice formats were inefficient in measuring complex problem solving, higher-order thinking and communication skills (Lipman, 1987). The American Association of School Administration (1989) reported that most standardised achievement tests at that time measured basic skills and could not measure the essential higher order thinking skills (cited in Allen, 1996). Bowers (1989) views the goal of standardised tests as an accountability function, whereby, the assessor then uses students' scores to make placement decisions, and to assess effectiveness of schools. Further, this limited objective increases reliance on short answer multiple-choice questions, the outcome being that active skills, such as drawing, repairing and constructing are lesser objectives. Other researchers agreed. With an expanded concept of learning, traditional assessments, for example paper and pencil testing, were insufficient assessment tools (Kulieke et al., 1990), and others continued that traditional assessment focuses on memory, rather than the crucial measurements of scientific process skills and knowledge (Baxter & Glaser, 1996; Demers, 2000; Shymansky; et al., 1997).

Over the last few years, however, science curriculum reforms have relied upon constructivist learning theory that requires a unique context for learning, capturing the attention of educators, researchers and policymakers (Brown; & Shavelson, 1996; Chang & Chiu, 2005; Clark, 2004; Gail, Elde, & Glaser, 1996; Haury, 1993; Herman et al., 1992; Luongo, 2000). This theory involves practical experience which allows students to meet their needs, and build their skills and knowledge in an interactive environment. The teaching environment that is guided by traditional tests does not allow for such change (Kane et al., 1997; Watt, 2002). Therefore, including other methods such as observing student performance, critiquing student products and conducting interviews are more suitable. Critical researchers continue to argue that educators should concentrate on finding and developing alternative assessment methodologies. Wiggins (1990) for example, inspired educators to build assessment devices out of traditional test methods. He attempted to create alternative assessment methods that require students to be effective in academic performance with gained knowledge.

Significant research focuses on students' achievement standards and the role of assessment in school science, with many educators criticising student performance outcomes realised by traditional testing:

> It is argued that without a clear window on students' complex thinking and problem-solving skills, not only do we fail to evaluate our students and instructional programs adequately, but we also communicate to teachers, parents, and students that such untested skills are not very important (Aschbacher, 1991, p. 276).

2.1.3 Performance-based assessment developments

In the early 1980s, the Assessment of Performance Unit (APU) in the United Kingdom conducted the first significant student performance assessment program (Orpwood, 2001), and its influence on the measurement of knowledge attainment spread widely. Performance assessment methods have proliferated in the intervening years, some focusing on processes and performance, others on student products. All forms evaluate students' ability to reason, use critical thinking skills, demonstrate solution strategies, and provide justifications to support answers (O'Leary & Shiel, 1997; Parke, 2001). This thesis defines performance assessment as "any type of assessment that goes beyond the use of traditional tests" (Chapter 1, definitions).

However, there are many others within the literature, such as Marzano, Pickering, and McTighe (1993), who define performance assessment as “a variety of tasks and situations in which students are given opportunities to demonstrate their understanding and thoughtfully apply knowledge, skills, and habits of mind in a variety of contents” (p. 13). They propose 5 dimensions of learning which provide a framework for effective learning in performance assessment:

1. positive attitudes and perceptions about learning
2. thinking comprised in acquiring and integrating new knowledge
3. thinking in extending and refining knowledge
4. thinking in using knowledge meaningfully, and productive habits of mind.

Performance assessment is a continuum of assessment formats ranging from the simplest student-constructed responses to comprehensive demonstrations or collections of work over time (Elliott, 1995). Performance assessment has three characteristics: alternative assessment to distinguish it from other assessment approaches such a multiple-choice testing, authentic assessment to highlight the real world nature of task, and assessment that requires students to perform, develop, and construct a product or a solution under defined conditions and standards (Kane et al., 1997). Haury (1993) has diverse aims for performance assessment: instruction and student evaluation, and for program diagnosis and accountability. Similarly, Lomask, Baron, and Greig (1998) distinguish between two performance assessment types; classroom-embedded assessment, an integral part of instruction used for instructional feedback, and on-demand assessment used for accountability, monitoring and placement purposes. The same formats of assessment such as portfolios and exhibitions can be used for each purpose. Although Mitchell (1989) suggests that performance-based assessment, "can take as many forms as imagination will allow" (in Jorgensen, 1994, p. 64), Rudner and Boston (1994) articulate its forms as projects, group projects, oral presentations, constructed-response questions, essays, experiments and portfolios. A review of the literature presented by key researchers in the field (Akerson et al., 2002; Firestone, Mayrowetz, & Fairman, 1998; Shepard & Others, 1996; Shymansky, Yore, & Anderson, 2004) establishes the following elements of performance-based assessments occurring under ideal circumstances:

- the process is examined as well as the product, and should represent a full range of learning outcomes by assessing students' writing, products, and performance
- tasks are situated in authentic, worthwhile, and/or real-world contexts
- the complexity of content knowledge and skills is preserved
- higher order thinking skills and deepened understanding are assessed
- criterion-referenced assessment approaches based on important learning outcomes rather than norm-referenced are applied
- often occurring over time, on-going, and embedded in instruction rather than separated from learning
- consists of either individual or group performances
- involves teachers in most of the design, implementation, evaluation and scoring.

2.2 An adapted theoretical framework of science classroom assessment

This section presents an adapted conceptual framework of classroom assessment. It was developed by Shepard (2000a; 2000b) with the aim of supporting teaching and learning based on a constructivist perspective. The Shepard framework as shown in Figure (2-1) consists of three parts that demonstrate the key perspectives of constructivist learning theory and key ideas of contemporary reform in curriculum and classroom assessment in general. The key changes in the newly developed framework occur under the main principles that exist within the original framework by adding three main ideas concerning cooperative learning, attitudes, and authentic learning. The additional two components of the model have been modified to encompass science curriculum and performance-based assessment.

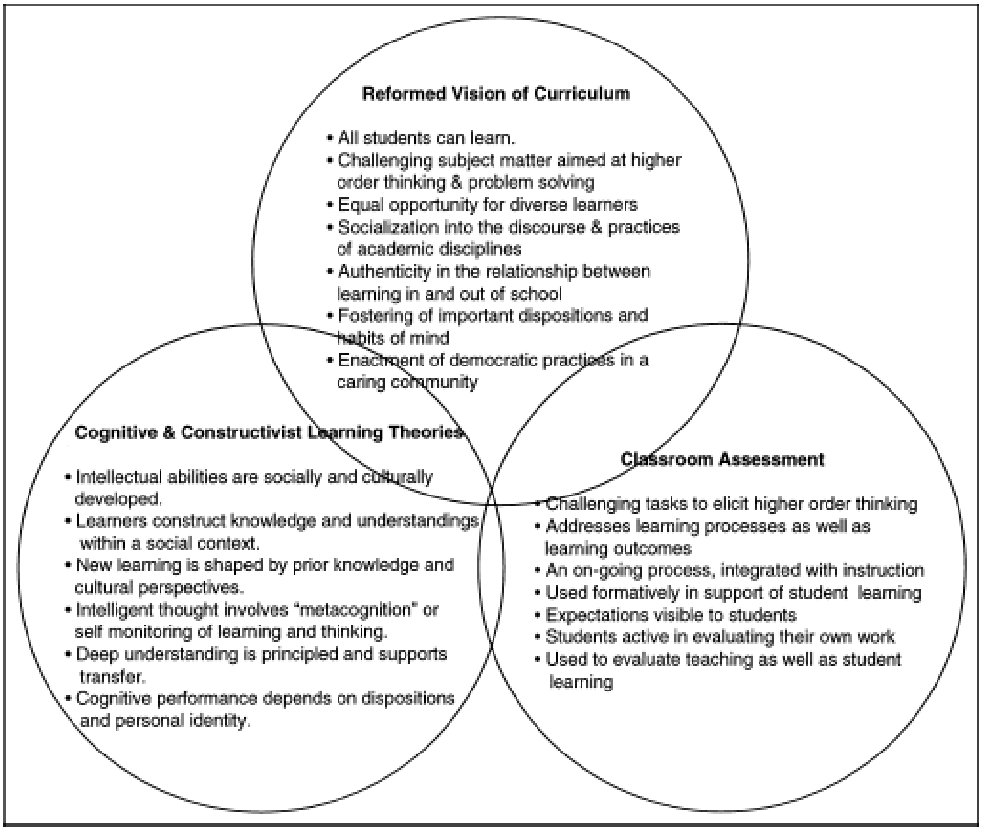

Figure 2.1 Shepard's framework of shared principles of curriculum theories, psychological theories and assessment theory characterising an emergent, constructivist paradigm (Shepard, 2000a; 2000b)

Specific adaptations to the framework, as shown in Figure (2-2), highlight characteristics of performance-based assessment in the primary science classroom, and comprise a three part figure built to emphasise contemporary changes in learning theory, curricula and assessment. The linking circles illustrate the consistency and interrelatedness of these ideas. Each part of the figure is described with attention to assessment, as the focus of this study. As Shepard (2000b) developed the framework, the learning theories' section focuses on social constructivist theory, summarising the widely shared notion between cognitive and constructivist theories. The curricula circle focuses on the science curriculum reform. The two parts serve to elaborate a reconceptualisation of performance-based assessment (the third circle) through their relationships to changes in both learning methods and science curricula.

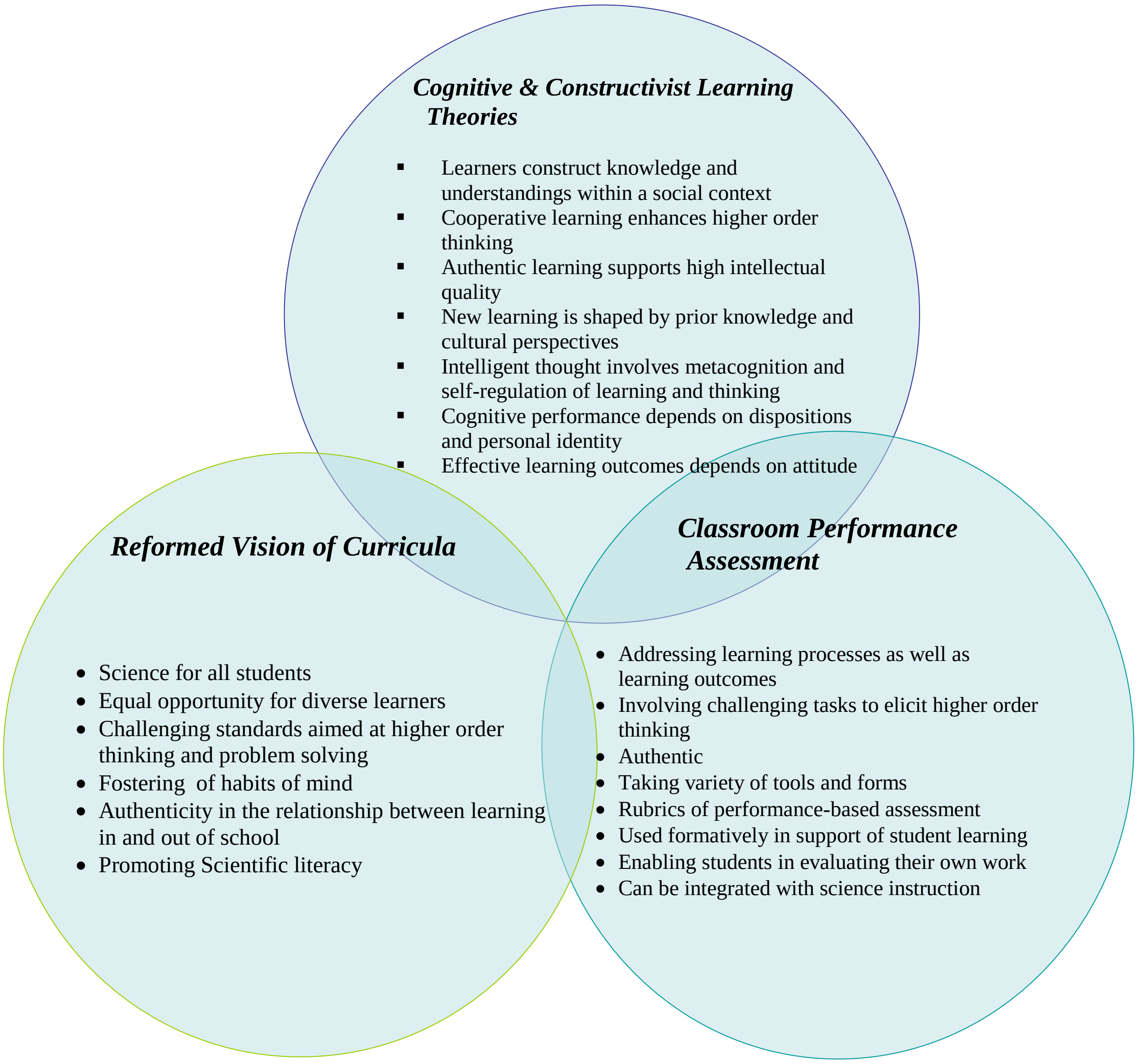

Figure 2.2 Learning theories, curricula perspectives and assessment theory: an emergent, constructivist paradigm adapted from Shepard (2000a; 2000b)

2.2.1 Cognitive and social constructivist learning theories

Shepard (2000b) lists a combined set of propositions from both cognitive and social constructivist theories to create a collective set of assumptions on learning. The prime feature of this new paradigm is that “it brings together these two perspectives to account for cognitive development in terms of social experience” (p. 18). Consistent with Shepard, this study is concerned with constructivist learning theory rather than epistemology, and implications of theory for changes in both science curricula and assessment.

Constructivism embraces much of the contemporary cognitive, sociocultural and linguistic theories, presenting a basis for addressing learning that behaviourism and cognitive theories do not offer individually (Yore et al., 1998). However, constructivism takes different forms such as *personal constructivism*, *radical constructivism* and *social constructivism* which are diverse in emphasis, but share many common perceptions about learning which enhance an attempt to bridge the gap between them. The emerging integration of personal and social perspectives within constructivism was scrutinised in 2002 by the Convention of the American Psychological Association and the North American Personal and Construct Network (Raskin & Bridges, 2004). In general, the constructivist theories from the conferences are based on the broad notion that learning and understanding are not passively received, but are constructed through negotiation of meaning (Palincsar, 1998; Puacharearn, 2004).

The following discussion relates to the seven elements of cognitive and constructivist learning theories illustrated in Figure 2.2.

2.2.1.1 Learners construct knowledge and understandings within a social context

Learning and understanding are considered essentially socio-cultural activities, central to conceptual development (Palincsar, 1998). Based on Vygotsky's theory, beliefs are transmitted over history by tools of consecutive mental contributions which exceed information from those more capable to those who are less so (Roth, 1995). The means by which these transmissions are affected are through language and cultural creations such as literacy, science, and technology (Roth, 1995). Bruner and Haste (1987) assume that through the social environment, the child attains a structure for understanding experience and realises how to negotiate meaning in a way matching the requirements of the culture. Further, *making sense* is a social process that is constantly placed in a cultural and historical context (as cited in Gipps, 1999, p. 373).

Vygotsky's theory offered a framework for realising how social interaction between expert and child can provide both a model of knowledge and occasion for guided practice where the child could ultimately internalise needed skills and employ them individually (Shepard, 2000b). The child first finds the means of making sense of others and construct awareness which allows the child to organise and relate the self to the social environment (Roth, 1995), thus language becomes a tool through which children construct meaningful contact with their surroundings. In these surroundings, as well as through interactions with others, the roots of their intellectual performance are found and can be internalised (Roth, 1995). The transformation of development from a cultural to an internal level, according to Vygotsky, occurs in the *Zone of Proximal Development* (ZPD), which is defined as "the distance between the actual developmental level …and the level of potential development … under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). Hedegaard (1990) confirms that the underlying statement behind Vygotsky's concept is that psychological development and instruction are socially surrounded; to comprehend a student's performance, the surrounding society and its social relations must be investigated.

Within the ZPD, as Henry (2002) advises, students need the support of teachers to keep their attention on the task, motivated, working within the scaffold teaching environment, and ensuring students are constantly challenged. With teacher control and support, students are able to understand the concept behind new information or procedures, or improve a task autonomously. The level of support could be estimated by teachers. When students face difficulties or show misunderstanding. Teachers should offer direct support and guidance until they consider that students have less need for direct assistance from the teacher (Ritchie, 1998)

Cole (1985) extends the notion of ZPD to involve any context containing participants exercising differential responsibilities by virtue of differential expertise (cited in Roth, 1995). According to Roth (1995) and Tudge (1990), discrepant knowledge and skills is developed and employed for cognitive growth in collaborating groups; thus students can distribute tasks, and scaffold their skills to achieve greater accomplishments than any one individual within the group.

Based on Vygotsky's concept of ZPD, many approaches to scaffolding have emerged (e,g.,Quintana, Krajcik, & Soloway, 2002; Warwick & Maloch, 2003) to guide empirical studies. The ZPD is extended to group contexts, examining methods by which learners can scaffold one another's learning within collaborative situations (Mercer, 2000).

2.2.1.2 Cooperative learning enhances higher order thinking

Research attention within social constructivism is directed to students learning in groups (Mason & Santi, 1994). Roelofs and Visse (2001) state that " within constructivist notions of learning, the acquisition of knowledge is regarded as a process of cooperation and co-construction of knowledge" (p.7). Cooperative learning has its foundations in constructivism, where students are encouraged to construct their learning based on a framework of discussion and argument with other students (Ransdell, 2003). Mason and Santi (1994) state that "The basic assumption within a Vygotskian frame of reference is that reasoning in children is mainly manifested in the externalized form of discussing and arguing with others" (p. 3). Cooperative learning however, is addressed within the Piagetian framework in which the mechanisms promoting development are known as cognitive conflict or sociocognitive conflict (Tudge, 1990).

Millis (2002) argues that cooperative learning endorses a shared sense of community. Learning, like living, is a naturally social phenomenon. This approach provides students the opportunity for corroboration and encouragement throughout organised classroom communication. An intellectual synergy is developed, and constructive relationships typically appear. Johnson and Johnson (1989) argue that higher order thinking occurs when learners are provided with the tools to interactively engage in high-level discussions, leading to greater theoretical understanding. After reviewing 122 studies conducted between 1942 and 1980 that compared individual, competitive and cooperative learning, Johnson and Johnson (1988) found that students learn more by cooperative interaction than other methods, and they are more positive about teachers, subject areas, and school when they learn cooperatively. Additionally, they found students are more positive and effective with interpersonal relationships when working cooperatively. In another study, Stanne, Johnson, and Johnson (1999) reviewed studies on the impact of the three types of social interdependence on personal achievement. They found that cooperation promotes significantly higher motor performance than competitive and individualistic efforts. Hwang, Lui, and Tong (2005) also reported positive results for cooperative learning, finding that these students significantly outperformed those who were taught using a traditional teaching method.

Rhem (1992) asserts that cooperative learning methods can take many forms, ranging from mutual assistance and discussions in class, to a complex environment including challenging tasks, and highly heterogeneous groups (Fore III, Riser, & Boon, 2006). Based on Johnson and Johnson’s work, elements for consideration in cooperative learning include positive interdependence, face-to-face productive interaction, group processing, individual accountability, and interpersonal skills (Brown & Thomson, 2000). *Success for all* is a later initiative for Slavin, that combines the essential elements of effective instruction with cooperative learning in the elementary grades (Slavin & Madden, 2001). Fore III, Riser and Boon (2006) reviewed Slavin's work, concluding the researcher is exploring generic principles of quality instruction, and a comprehensive approach to education reform.

Again, Rhem (1995) offers four components consistent with cooperative learning. The first component is *motivational context*, that is, students can choose linkages to knowledge, thereby engendering motivation. Secondly, learner activities requiring performance deepen learning links. Thirdly, interaction with others a process which directs learning that teachers would not reach and individual students could not administer. Finally, a well-structured base is linked to offer new material in an organised manner, and for engaging with, and restructuring, the students' inherent knowledge.

2.2.1.3 Authentic learning supports high intellectual quality

Research influenced by constructivism, shows, that in addition to students' interactions, an active role is necessary in the acquisition and use of knowledge within authentic learning situations (Roelofs & Houtveen, 1998). Students should be encouraged to explore phenomena in their natural and social environment (Bencze & Hodson, 1998). Newmann, Marks, and Gamoran (1995) concluded students often absorb information from teachers and repeat it, with little correlation between activities in the classroom and the external word. Roelofs and Terwel (1997) suggest that an inflexible knowledge transmission is inoperative in a real-life situation. Thus, students' work can be intellectually shallow and weak (Newmann, Marks, & Gamoran, 1996), as exemplified by the group sharing of answers, or short answers without comprehension of the cumulative meaning. Roth (1995) concluded that this form of problem solving is clearly stated, relatively simple, pre-structured and usually has a single answer; thus rote learning at school may be unrelated to students' lives.

This critique influences the concept of authentic learning in which students can enrich their lives by constructing knowledge related to their environments (Newmann, 1991). Newmann and Wehlage (1993) use the word *authentic* to discriminate between achievement that is meaningful and that which is insignificant, determining three criteria for authentic achievement, students;

(1) construct meaning and produce knowledge;

(2) use disciplined inquiry to construct meaning; and

(3) aim their work toward production of discourse, products, and performances that have value or meaning beyond success in school (p. 8).

Jobling and Moni (2004) state that authentic learning experiences necessitate learning situations to be actual and purposeful, motivational, and realistic in terms of the classroom environment in which learning procedures are administrated. From this viewpoint, they add, a range of opportunities required to be available for students to recognise, comprehend and practise such situations in ways that allow teaching and learning needs to be scaffolded

Authentic learning cannot occur without authentic assessment and authentic content reflective of the subject matter (Maksimwicz, 1993). The principles of authentic learning comprise authentic intellectual accomplishment external to school, such as mastery demonstrated by specialists, to guide intellectual quality for schooling (Newmann, Marks, & Gamoran, 1996b). The researchers define authentic learning through three criteria which are construction of knowledge, disciplined inquiry, and value beyond school.

Rick (1998) describes elements of authentic learning as students interactively solving problems, making decisions, and understanding concepts in real situations where there are no artificial boundaries. Such situations simultaneously involve students' knowledge, skills, and attitudes, and when employed in one context, apply in another. Similar to Newmann's view, Rick asserts that authentic learning is driven by *essential learning* that is meaningful to students, and situated in a context involving real-life standards of quality where students publicly exhibit their learning.

2.2.1.4 New learning is shaped by prior knowledge and cultural perspectives

Studies into human cognition and learning (Alvermann & Hague, 1989; Heit, Briggs, & Bott, 2004; Holden & Yore, 1996; Jones, Todorova, & Vargo, 2000; Osman, 1994) shows that prior knowledge is an important student variable in learning science. Ausubel (1968) summaries this as: "If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows" (cited in Holden & Yore, 1996, pp. 5-6). Prior knowledge is defined by Dochy, Moerkerke and Martens (1996) as:

> The whole of a person's knowledge ... [that] is dynamic in nature; is available before a certain learning task; is structured; can exist in multiple states,… is both explicit and tacit in nature, and contains conceptual and metacognitive knowledge components (p. 311).

Dochy (1991) presents a mapping of prior knowledge in which forms of knowledge are flowing and dynamic, and differ not just between persons, but also within individuals, as well as resulting from person, task, or context variables. As a supplement, the forms of knowledge differ in terms of situation, order, or volume. In addition, all forms of knowledge are interactive; the attendance or activation of one form of knowledge can directly or indirectly affect any other. Dochy states that knowledge cannot be dichotomously classified as tacit or explicit. Similarly, implicit and explicit knowledge exist in a condition of dynamic interface for particular tasks. Unused explicit knowledge can change into used explicit knowledge. Similarly knowledge can also operate implicitly under other conditions.

Jones, Todorova, and Vargo (2000) indicate that pre-existing knowledge of material relevant to the subject is one of the strongest factors influencing the subject's understanding. According to Heit, Briggs and Bott (2004) and Shepard (2000b) prior knowledge forms new learning. It can have positive and/or negative effects on learning (Jones et al., 2000). Prior knowledge accelerates the learning process, and on the other hand, it can reduce learning if it includes misconceptions. So, to avoid the negative impact of prior knowledge, learning should be guided so that it 1) develops positive and reliable prior knowledge and 2) abolishes or decreases the impact of misconception (Jones et al., 2000). Shepard (2000b) suggests that open negotiations or discussions are useful to convey large amounts of information about students' primary interpretations and conceptions.

2.2.1.5 Intelligent thought involves metacognition and self-regulation of learning and thinking

During the interpretation of activities, learners should understand the concepts underlying the ideas, and consistently, and intentionally scrutinise their developing understanding as they attempt to learn or use new experiences (Mason & Santi, 1994). Students should also be encouraged to use metacognitive skills to develop their conceptual growth and understanding through various kinds of techniques such as argument (Kuhn & Dean Jr., 2004). Metacognition has been variously interpreted:

- Livingston (2003) proffers that it permits students to be successful learners, and this is allied with intelligence;
- Holden and Yore (1996) indicate that two components are involved: self-appraisal and self-management;
- Flavell divides metacognition into metacognitive knowledge and metacognitive experiences, and then subdivides the first part into three types: "knowledge of person variables, task variables and strategy variables" (Livingston, 2003, p. 3).

However, metacognition is simply defined by Brown (1978) as "thinking about thinking" (cited in Mason & Santi, 1994, p.5). Brown (1978) divides metacognitive activities into two categories: the first includes activities related to conscious reflection on one's cognitive abilities, the second category concerns activities related to self-regulated mechanisms during learning or problem solving (Mason &

Santi, 1994). According to Kuhn, Amsel, and O'Loughlin (1988), the essential aspect of metacognition is the ability to think explicitly about a belief rather than merely obeying that belief.

To support development of metacognitive attributes, Kuhn and Dean (2004) suggest students should reflect on and evaluate the purpose of their activities by asking questions such as: '*Why are we doing this?'* And *'What was gained from it?* This approach thus internalises the structure of their thinking. In this way, metaconceptual dimensions can be activated in students through collective classroom discourse such as dialogic and collaborative learning situations (Mason & Santi, 1994).

Students' activities and interactions are influenced by self-regulation, which plays a significant role in both cognitive and social development (Diaz, Cynthia, & Williams, 1990). Self-regulated students engage in metacognitive processes which involve planning and organising their learning and self-evaluation (Ross, Salsbury-Glennon, Guarino, Reed, & Marshall, 2003). Similarly, self-regulation relates to different types of mental activities individuals use to control and manage their own thinking processes (1999). Cleary and Zimmerman (2004) view self-regulated learners as those who proactively direct their activities or plans to set goals, and depend on feedback to adapt or change their strategies and behaviours when they may fail. However, Lemos (1999) argues that "self-regulation should not be equated with the process of adjustment to changing circumstances" (p. 471). As a variety of behaviors can be employed for these processes, self-regulation requires a personal standard of behaviour adaptation relating to an individual's personal goals, rather than to changing circumstances. Therefore, self-regulation comprises the individual's capability to systemise behaviour according to personal goals and behavioural standards.

Several educational psychologists (Sperling, Howard, Staley, & DuBois, 2004; Zimmerman, 1999) argue that self-regulation is a complex construction of processes that self-regulated learners use to acquire new knowledge, and skills, to improve circumstances for success (Boekaerts, 1999). Ross et al. (2003) reviewed theoretical models generated to identify the components and process of self-regulation and identify common areas. First, learning contains an interface between internal factors such as prior knowledge, and motivation, and external factors, such as teaching style, task requirements, assessment requirements and accessible resources. Second, learning includes the organisation of goal setting and metacognition. Third, the learner must apply motivational and cognitive learning strategies. Finally, the learner engages in performance on academic tasks, and further, engages in the self-reflection and self-evaluation of this performance.

2.2.1.6 Cognitive performance depends on dispositions and personal identity

Until metacognition was studied, research on motivation was set apart from learning research (Shepard, 2000b). Researchers previously believed that students do not employ known strategies unless motivated. As metacognition literature developed, researchers in learning and motivation have explored shared interests in metacognition and motivational self-regulation, the latter viewed as a motivational coordinate of metacognition (Prawat, 1998).

Recent motivational theory and research focus on social-cognitive rather than need constructs; that is, on various cognitive, motivational, and regulatory constructs (Pintrich, 2003). Pintrich outlines three assumptions of social cognitive models of motivation. Firstly, that motivation is a dynamic, many-sided phenomenon, and secondly, that it is more placed, contextual, and domain-specific. The last assumption involves the essential role of cognition. Motivation is formed by an individual's active regulation of his/her motivation, thinking, and behaviour that mediates the relationships between the individual, situation, and eventual achievement. Accordingly, to understand students' motivation, researchers identify 5 dimensions that represent accepted social-cognitive motivational theories that are goals orientation, self-efficacy, attributions, interest, and values (Linnenbrink & Pintrich, 2002; Pintrich, 2003).

Cognitive variables of learning goals and performance goals relate to students' willingness to engage in academic tasks, that is, a challenge to an individual's ability or competence (Dweck, 1986; Dweck & Leggett (1988). The authors demonstrate that students displaying adaptive *mastery-oriented* traits appear to enjoy exerting effort in the pursuit of task mastery, whereas students who display maladaptive *helplessness* tend to evidence negative affect and negative self-cognitions when they confront obstacles. Interestingly, they found that students who avoid challenge and show impairment in the face of difficulty are initially equal in ability to those who seek challenge and show persistence.

Through his work, Bandura (1989; 1993); Bandura and Barbaranelli (1996) argue that students' beliefs in their efficacy to control their own learning activities and to overcome difficult subject matters affect their academic motivation, interest, and achievement. Individual goal setting is influenced by self-appraisal of competencies. The stronger the perceived self-efficacy, the higher the goals that individuals set for themselves and the firmer their commitments to those goals. Students holding a low belief of self-efficacy for accomplishing a task will often avoid it. Additionally, they also lack interest in class, fail to prepare for assessments, and even fail to attend school. On the other hand, students who have more positive self-efficacy beliefs are more likely to perform harder, persist, and eventually achieve at a higher level. Hsu (2001) found that students who felt performance standards were more useful and interesting were observed to perform better in performance-based assessment.

Motivational research includes reference to the attribution theory, that is based on the proposition that when a failure or success occurs, individuals will analyse the situation to determine the perceived causes for failure or success (Weiner, 1985). Adverse causes involve environmental factors, such as a disturbing testing environment or bias against the teacher, or individual factors, such as lack of knowledge, or failure to plan sufficiently for the test (Linnenbrink & Pintrich, 2002). These perceived causes share three common causal dimensions that are locus, controllability, and stability. Causal locus refers to the site of a cause, which is either inside or outside the performer. Examples of locus are capability and endeavour, internal causes of success, whereas, relief from performing the task or assistance from others are external causes. Causal stability refers to the duration of a cause. Some causes, such as mathematical aptitude, are perceived as constant while others, such as chance, are considered unstable or temporary. Finally, causes such as effort are subject to volitional modification, whereas others cannot be willfully changed such as luck and aptitude (Weiner, 1985, 2000).

Whereas some motivational concepts such as task value and self-efficacy focus on beliefs and cognitive representations, interest has been conceptualised both as a personal tendency and as a psychological status (Ainley et al., 2002). The latter, psychological status is categorised by focused attention, increased cognition and effect. Hidi (2001) suggests that there were two approaches to the role of interest in learning. The first, relating to the impact of personal favourites; that is, on how an individual's already shaped interest affected performance. The second is text-*based*, an approach that focuses on how the interestingness of stimulus materials influenced subjects' performance. According to Linnenbrink and Pintrich (2002), and Tobias (1994), interest has the capability to influence academic attainment and other academic enablers. It is positively associated with achievement, with the use of deeper cognitive strategies, and increased attention, and persistence.

Although interest can undoubtedly motivate students to learn, it also matters whether students care about, or think the task is important (Pintrich, 2003). In expectancy-value theory, this was addressed as an important intermediary of subsequent achievement behaviour. Wigfield et al. (1997) assessed change over three years in elementary school children's competence beliefs and subjective task values in different domains. The authors found that children's competence beliefs related more significantly to their interest in academic activities than to the perceived usefulness of the activities.

2.2.1.7 Effective learning outcomes depends on attitude

Attitude is a focus of cognitive psychology, through the assumption that attitudes are as important as cognitive variables in influencing, and possibly predicting, learning and other outcomes (Koballa, 1988). Theory regarding attitude as a learning component has changed. Shrigly, Konalla and Simpson (1988) criticise the Hovalnd's model of attitudes that is based on behaviourism principles, assuming that recipients are active participants who receive, interpret and construct their belief system and, thus, attitudes. They found that attitudes are learned from many sources and the social influence of others is integral to this process. Social constructivist perspectives broaden the factors that may influence students' attitudes to involve teachers, parents, peers, cultural beliefs, and classroom climate (Yore et al., 1998; Zacharia & Barton, 2004). Shrigley (1983) describes the key elements of the attitude: they are learned; can predict behaviour; are affected by the social influences of others, by readiness of the individual to respond; and are evaluative (Flower, 2000).

Koballa (1988) states that attitudes are learned from experience, and therefore can be taught. Papanastasiou and Zembylas (2004) define attitudes as "the favourable or unfavourable response to things, people, places, events or ideas" (p. 260). Social psychologists have long viewed attitudes as having three components: the cognitive, the affective, and the behavioural (Eagly & Chaiken, 1993; Petty & Wegener, 1998). The cognitive component is a set of beliefs about the attributes of the attitudes' object. The affective component includes feelings about the object. Finally, the behavioural component pertains to individual's responses toward the object (Salta & Tzougraki, 2004). Koballa and Crawley (1985), and Koballa (1988) find that an attitude towards science cannot be observed directly but can be based upon descriptive beliefs. It can be observed as a positive or negative feeling about science. Koballa (1988) considers statements such as *I like science* or *I love to teach science* as expressions of attitudes toward science.

Whilst recent educational research focuses on the influence of social experience in formulating attitude concepts, the relationship between attitudes and achievement has long been the subject of research. Bloom (1976) found that up to 25 per cent of the variance in school achievement may be attributed to students' attitudes toward the subject matter, as well as to their school environment, and their self-belief (cited in Papanastasiou & Zembylas, 2004). Marzano et al. (1993) state that "without positive attitudes and perceptions, students have little chance of learning proficiently, if at all" (p. 7). Students require certain attitudes and perception, and feeling comfortable with learning. A positive attitude toward school is important for cognitive development and to enhance learning both formally, and informally after the direct influence of the teacher has ended and attitudes are communicated to friends and peers (George & Kaplan, 1998).

Previous literature proposes that attitude is an essential component in students' learning, and addresses attitude in relation to specific subjects, such as, mathematics and science. Research findings in science education however are equivocal regarding the relationship between attitudes and science achievement (Ingram & Nelson, 2005). For example, some studies (Dechsri, Jones, & Heikkinen, 1997; Freedman, 1997) found that attitude influences achievement, while others found that achievement influences attitude (Reynolds & Walberg, 1992); and there are findings of a low positive relationship existing between attitudes and achievement (Keeves & Morgenstern, 1992).

This modest relationship may derive from a lack of theoretical framework of attitude (Rennie & Punch, 1991; Shrigley et al., 1988); an inability to measure students' attitudes against a *generalised science* concept (Zacharia & Barton, 2004); lack of suitable variables for the measurement of attitude (Salta & Tzougraki, 2004); ineffectual teaching and the influence of home background (Papanastasiou & Zembylas, 2004), or the limitation of assessment tools that focus on this cognitive domain. However, outcomes from the Trends in International Mathematics and Science Study (TIMSS, 1999a) found a clear positive association between attitude towards science, and science achievement, across all participating countries in TIMSS 1999.

Recent attitudinal literature has examined dimensions including self concept, teaching style, family social economic background, and local culture (Krogh & Thomsen, 2005). These factors represent a reduction in the complexity of attitude concepts and introduce influential research on attitudes. Krogh and Thomsen applied a theoretical framework of cultural border crossing, including family background (parents' occupation and thinking style), low general school interest among family and peers, and students' non-scientific perception, to investigate the importance of cultural aspects on attitudes toward physics, relative to other personal and endogenous classroom factors. They found that there are three important predictors for attitudes toward physics: Students' physics-related self-concept, the value-oriented border crossing factor reputation (keywords strange, boring and different) and ‘teachers showing an interest in students as persons. Other factors which affect attitudes have been found by Papanastasiou and Zembylas (2004). Based on TIMMS collected data, they investigated the locality of the relationship between attitudes towards science, self-beliefs and science achievement in three countries (Australia, Cyprus, and the USA), using a model incorporating two groups of environmental variables (teachers, parents, and peer groups), and learner-related variables (self-beliefs). The findings for all three countries included a latent variable of importance for self, parents, and friends, and that students’ impressions of their self-perceived science ability significantly predicted the latent variable of science importance. However, Papanastasiou and Zembylas found differences between the three countries on other relationships that describe relationships between attitudes in different subject areas, or the association between the influence of parents and peers. They concluded that the differential effects that science achievement and science attitudes can have on each other are dependent on the characteristics of the educational systems within each country.

Osborne, Simon, & Collins (2003) indicate that there were common aspects of teaching that were perceived to be effective by both teachers and pupils. These were:

- clear goals for pupil learning;
- clarity of communication of lesson goals and agenda to pupils;
- use of preview and review of lesson content;

- helping students to contextualize content in terms of their own experience
- and knowledge, as well as in terms of other teaching goals and learning experiences; some willingness to allow pupils to have input into goal and agenda setting;
- a supportive social context designed by the teacher to help pupils feel accepted, cared for and valued;
- an ability and willingness to allow for different cognitive styles and ways of engaging with the learning process among pupils, through multiple exemplification, and the use of different types of illustration and mode of presentation, and offering pupils a choice from a menu of possible ways of engaging; and a willingness to take into account pupil circumstances and to modify/pace/structure learning tasks accordingly (p. 1067).

Research supports instruction that engenders interest in science , and encourages students to engage critical thinking skills to improve achievement and attitude (Freedman, 1997; Jarvis & Pell, 2005). Therefore, instead of examining the bilateral relationship between attitudes and achievement, research focuses on the effect of new methods of teaching and assessment on both attitudes and achievement. Studies examining intuitive teaching approaches found positive effects regarding students' attitudes toward science (Bilgin, 2006; Ebrahim, 2004; Gibson & Chase, 2002; Shymansky et al., 2004).

Tobias (1992) reported that factors generating students' negative attitudes towards science include lack of interest and motivation, being passive recipients, competition within classes rather than cooperative learning, and rote learning based on problem solving instead of grasping concepts (cited in Bilgin, 2006).

2.2.2 Reformed vision of science curriculum

The elements of a reformed vision of science curriculum, summarised in Figure 2.2, set directions for contemporary educational science reforms. *Science for all* is a reformed principle addressed by scientists, science curriculum developers and international institutes (UNESCO, 1983) and adopted for many national science curricula. As science education reform is a continuous movement in many countries, students are encouraged to perform at higher standards according to their abilities, relating science to real-life, fostering enhanced dispositions and habits of mind, and promoting scientific literacy (Chang & Chiu, 2005; Shepard, 2000b).

Constructivist theories shape common features of science curriculum reform, despite aspects that differ between countries, such as political and social issues (Collins, 1998; Hodson, 2004). This is confirmed by the South Australian Curriculum Framework, which states that “the theoretical basis for the conception of learning in the SACSA Framework is provided by the family of theories of learning that are grouped under the title ‘constructivism” (SACSA Framework, 2001, p. 10). In this part, the main trends of science curriculum reforms that relate to the previous learning theories section are discussed.

2.2.2.1 Science for all students

Constructivist learning perspectives replace the previous discriminatory paradigm where elite students were given challenging subject matter such as science (Shepard, 2000b). Long-standing theories of learning affected not just science curriculum development, but also instructional styles, and educational policy. This theoretical perspective of differentiation for students from different backgrounds is described by Terman (1961, pp. 91-92):

> children of this group should be segregated in special classes and be given instruction which is concrete and practical; they cannot master abstractions, but they can often be made efficient workers, able to look out for themselves (as cited in Shepard, 2000b, p.7).

Since the mid-1980s, according to Earnest (2003), science education is viewed as a basic right to be provided for every student regardless of background, nationality, language, sex and socio-economic circumstances. UNESCO and its members are committed to school science as *science for all* (Fensham & Harlen, 1999).

International science curriculum development has a general commonality: Australia has the program *science for all citizens* (Science in Schools Research Project, 2003), similar to the United States' *Science for all Americans* (Rutherford & Ahlgren, 1991), whilst the United Kingdom has a policy that *all young people should have a broad and balanced science education* (Miller & Osborne, 1998, p.6). These commitments are overshadowed by issues of science education implementation and public awareness, which may be assisted by increased years of student science education (Fensham & Harlen, 1999; Hodson, 2004).

2.2.2.2 Equal opportunity for diverse learners

As noted in s 2.2.2.1, commitment to science education for all students is international (Fensham & Harlen, 1999). Despite diversity in science education methodologies, there is a commonality of providing students with opportunity to learn science in keeping with ability, prior knowledge, and attitudes (Hoffman & Stage, 1993). An example of this commonality in science curricula is a statement from the Ministry of Education in New Zealand:

> It is important to recognise students as individuals who learn at different rates and in different ways. It is not expected that all students of the same age will be achieving at the same level at the same time, nor that any individual student will necessarily be achieving at the same level in all strands of the science curriculum (Ministry of Education, 1993, p. 15).

Various strategies are employed to put this principle into practice (Fensham & Harlen, 1999), as the Australian School Innovation in Science project (Science in Schools Research Project, 2003) requires a "range of strategies is used to respond to students' different learning needs and preferences, and their social and personal needs" (p. 26). To demonstrate a particular component, it further suggests some strategies for teachers to provide diverse task types during each unit, to offer variations in tasks to give students opportunities to choose one type of presentation or method of approach; and to use different strategies to create a mood of cooperation and collaboration.

2.2.2.3 Challenging standards aimed at higher order thinking

Bianchini and Kelly (2003) conclude that science curricula and instructional practice standards are required to achieve the goal of science for all. The standards identify criteria for high-quality science practices that comprise the engagement of all students in the wide range of science content (Hoffman & Stage, 1993). The National Academy of Sciences in the United States (1996) made it clear that

> The intent of the Standards can be expressed in a single phrase: Science standards for all students. The phrase embodies both excellence and equity…Different students will achieve understanding in different ways, and different students will achieve different degrees of depth and breadth of understanding depending on interest, ability, and context (p. 2).

Standards, as a method of framing curricula, give form to science education (Collins, 1997). Kansas State Board of Education Standards (2001) defines standards as "general statements of what students should know, understand, and be able to do" (p. 10). The National Science Education Standards in USA determines that science education standards present both a vision and a set of criteria for evaluating development toward reaching that vision (Collins, 1998). Similarly, standards in the South Australian Curriculum and Accountability Framework (2001) provide a common point for educators in observing, evaluating and reporting on learner accomplishment over time.

The standards approach to science teaching, student learning and curricula is international (Groves, 2000), challenging science educators to implement change. These changes emphasise inquiry and problem-solving, in which students experience events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others (Kansas State Board of Education Standards, 2001). Standards reform endorses the use of inquiry for students, using both science processes and critical thinking skills (Gibson & Chase, 2002). The National Research Council [NRC] (1996) also asserts that "the Standards call for more than 'science as a process' in which students learn such skills as observing, inferring, and experimenting. Inquiry is central to science learning” (p. 2).

According to Abd-El-Khalick et al. (2004), and Haefner and Zembal-Sau (2004), inquiry in science learning is a recurrent and central theme in science education reform. Their research was conducted with K-12 students, and positive effects were found on students’ science achievement, cognitive development, science process skills, and understanding of science knowledge as well as improving attitudes towards both science, and school, when compared to students taught using a traditional approach (Chang & Mao, 1998; Gibson & Chase, 2002). Smith (1997) states that science educators vary in their approach to inquiry. The concept of inquiry can be viewed as a continuum where, at one extreme, elementary science teachers are in charge, selecting the problem, establishing methods of investigation, and guiding students toward a solution. At the other extreme, teachers facilitate, the students establish the questions and problems for study along with the methodology of their investigation. In addition, NRC (1996) claims that elementary science focuses on the processes of science, emphasising the skills of science such as observing, hypothesising and experimenting, but does not support the critical thinking and reasoning associated with scientific inquiry. Parker and Gerber (2002) assert that in inquiry pedagogy, students are involved in science activities that promote higher order thinking skills such as investigations. Then they communicate with their peers to discuss their ideas and explanations for science-related problems, thus allowing reapplication in real world situations.

The learning cycle method is an effective inquiry approach consisting of exploration, term introduction, and concept application (Lawson, 2001). The learning cycle approach involves methods of teaching such as laboratory experiments, demonstration and group work (Marek, Gerber, & Cavallo, 1999). This type of learning was originally developed by Robert Karplus as a teaching plan for the successful Science Curriculum Improvement (Rule, 1995), and further developed by Martin, Sexton, and Gerlovich (2001), who added an evaluation phase to stimulate a full range of student inquiry and reflect constructivist learning expectations.

Different approaches in inquiry may relate to concepts of inquiry in science reform, and issues of application of the concepts into classroom practice (Abd-El-Khalick et al., 2004; Haefner & Zembal-Saul, 2004). Recent science reform research examined science inquiry as cognitive outcomes in which students were expected to master a set of inquiry- related skills and to develop understanding about inquiry, consistent with the goal of scientific literacy (Abd-El-Khalick et al., 2004). Inquiry provides students with an important experimental foundation and they become critical consumers of science and participants in a scientifically laden culture (Abd-El-Khalick et al., 2004).

Authentic inquiry can be enhanced by the use of problem-based learning to promote active learning and higher order thinking, thus, promoting research on problem-solving ability (Chin & Chia, 2006). Problem-solving approaches can assume two forms. Firstly, well-defined problems have starting and ending positions, for which steps can be taken to solve the problem (Fortus, 2003); and secondly, for ill-structured problems, where the necessary information for a solution is not available, and there is more than one answer (Chin & Chia, 2006). The earlier model of problem-solving with highly structured activities, was criticised on the grounds that the activities were not related to students' lives and were discrete rather than connected to a particular set of questions, or organised around a phenomenon (Marx & Blumenfeld, 1997).

2.2.2.4 Fostering important dispositions and habits of mind

Scientific habits of mind are an integral part of contemporary descriptions of scientific literacy (Volkmann & Eichinger, 1999). For example, in the United States, Project 2061 considers habits of mind as an essential element for all students in science, mathematics, and technology (AAAS, 1997). Habits of mind include integrity, diligence, curiosity, openness to new ideas, skepticism, and imagination. In Australia, the Middle Years of Schooling Research and Development [MYRAD] project launched the Thinking Curriculum, piloting Habits of Mind in 2001/02 with one grade and then extended into all middle school grades (Anderson, 2003).

Within curricula developed around broad outcomes and focused on continuing, transdisciplinary learning, students give meaning to their learning (Costa & Kallick, 2000b). Marzano, Pickering, and McTighe (1993) argue that although content knowledge is important, developing habits of mind that enhance self-directed learning is of greater value. In their series, *Habits of Mind*, Costa and Kallick (2000a), suggest new reform structures of curricula based on habits of mind, "a systemic map of increasingly broader levels of curricular outcomes" (p. 54), involving four levels including activities, content, processes, and habits of mind. Based on their experience, Costa and Kallick (2000c) determine that although habits of mind are beneficial for students learning, for teaching, assessment, and school culture, the impact will be apparent only after considerable practice in a social setting. The principle of Habits of Mind is illustrated by a representative of the Institutional Evaluation Department in Venezuela:

> We have been practicing thinking flexibly. We allow ourselves to stop a discussion when it's needed, without feeling that we are not on task, not fulfilling our obligations, or losing time. We bend to situations or decisions where taking a rigid stance would only hinder our work (Costa & Kallick, 2000c, p. 90).

2.2.2.5 Authenticity in the relationship between learning in and out of school

Scientific literacy and authenticity are of primary interest to researchers (Chang & Chiu, 2005). Science educators are seeking an authentic view of the relationship between science, technology, and society, with a connection between science and real life. Orpowd (1994) states that:

> Nothing motivates students to higher performance more than a sense that what they are studying is of real relevance and importance to themselves, their lives and personal aspirations. Science and technology are of enormous relevance to the lives and careers of all young people in school today (p. 16).

As noted in this section, contemporary science curricula consider the nature of scientific inquiry and the complex relationships among science, technology, society, and the world beyond school (Bencze & Hodson, 1998), thus the dimension of authenticity has become popular. For instance, Chang and Chiu (2005) comment on science curricula in Taiwan and state that "the curriculum reform emphasises the importance of linking the content of the curriculum with life-related context" (p. 118). As part of a collaborative project in Detroit, Rivet and Krajcik (2004) developed and implemented Project-Based Science on twenty-four teachers and over 2500 students with the goal of supporting students' science learning through inquiry about the real world. Achievement outcomes as measured by the pre and post-test indicated significant and consistently high learning gains. Further, the Ontario Ministry of Education called for a more authentic view of the nature of scientific practise at all levels of education (Bencze & Hodson, 1998). Bencze and Hodson (1998) also criticise science curricula designed to reach predetermined outcomes, perpetuating a view of the expert as one who knows, rather than one who uses knowledge to refocus doubt. An elementary classroom project that Bencze and Hodson describe is a model of science that recognises the fallibility, and theory dependence of observation, and experiment and integrates awareness as a negotiable element within the scientific community.

2.2.2.6 Promotion of scientific literacy

Connecting learning science to life issues and teaching promotes recognition among science educators that science is a product of its time and place, inextricably linked with its sociocultural and institutional location, and deeply influenced by its methods of generation and validation (Hodson, 2004). Laugksch (2000) reviewed literature on the concept of scientific literacy, finding it is placed in an historical context, and developing a theoretical framework for factors that influence its interpretation. These factors include the research dimensions of scientific literacy, such as goals of science education, conceptual definitions of the phrase, the relative or total nature of scientific literacy as a concept, different purposes for advocating scientific literacy, and different measurement methods.

The UK's 21st Century Science, project, Jenkins (2004) concludes, relates more to citizenship, and science for personal, and social use because science teachers' concerns are political, social or economic, rather than intently scientific. In Australia, Goodrum, Hackling, and Rennie (2001) conducted a national study, concluding that improved scientific literacy of students should be the goal of school science education, as scientifically literate persons are capable in both social, and economic sectors.

Goodrum et al. (2001) propose a number of recommendations to advance the quality of science teaching, and learning, and promote scientific literacy. The recommendations are underpinned by the conviction that science is an essential part of education for all students, but they argue the value of learning science relevant to everyday life. Miller and Osborne (1998) also call for a clarification of the aims of science curricula to aid in the selection of appropriate content and teaching approaches. Miller and Osborne emphasise however, the cultural and democratic justification for an understanding of science, claiming overuse of the notion that scientific knowledge is useful for action has led to estrangement amongst learners. The authors conclude that "scientific knowledge usually has to be re-worked and re-structured before it can be applied to most everyday situations" (p. 2011). Rennie (2005) asserts that the key to ensure benefits from learning science is to promote scientific literacy. Science curricula and projects generally give science literacy priority, for example in the USA, Project 2061 established science literacy as an important national goal for all students (Nelson, 1999).

Although the importance of scientific literacy is accepted by teachers, educators and researchers, the meaning of scientific literacy is not yet established (Rennie, 2005; Sharma, 2001). Goodrum et al. (2001) report that the science curricula in schools frequently fail scientific literacy:

> Unless we define scientific literacy clearly, we have no basis upon which to judge whether or not progress towards scientific literacy has been achieved, or what it is we need to do in order to assist students to progress (p. 12).

A definition for scientific literacy is therefore required. It should be that rejects science as a body of knowledge and promotes the use of science in everyday life (Rennie, 2005). The OECD's Programme for International Student Assessment (PISA) (2001) defines science literacy as "the capacity to use scientific knowledge, to identify questions, and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (p. 23).

2.2.3 Classroom performance-based assessment

Reform of educational assessment methods is required at all levels, from large scale tests to classroom assessment levels (Demers, 2000; Gail et al., 1996; Marzano et al., 1993). Reform of classroom assessment practices has three factors including the changing nature of education goals; the relationships between assessment, teaching, and learning; and the limitations of methods to evaluate performance (Marzano et al., 1993). Shepard (2000b) asserts that two fundamental methods should be considered to use classroom assessment to enhance students' learning. First, the content and quality of classroom assessment is developed to match learning aims, which involves matching assessment content with challenging science standards and linking it to situations of application. Second, the purpose of assessment must be changed to act as a tool for students' learning, and to develop teaching, rather than to grade students or judge the end product of learning.

Describing the assessment environment in a constructivist science, technology and society (STS) paradigm, Freedman and Lee (1998) analysed interview data to describe the assessment environment: and reported that learning is an active practice; the student has prior knowledge, and students take responsibility for their own learning. Accordingly, Freedman and Lee identify the following features of classroom assessment under this paradigm:

- Assessment is in a meaningful context, relevant to students.
- The process of learning continues during assessment.
- Assessment includes higher order thinking skills, and an application of knowledge and comprehension.
- A range of techniques is used in assessment.
- Assessment focus is on concepts, and issues, and their accompanying facts, and evidence.
- Assessment includes inquiry.
- Students go beyond initial information levels through elaboration doing in-depth analysis of ideas, issues and concepts.
- Students solve problems in which they extend and re-conceptualise knowledge in new contexts.
- Students interact with one another during assessment (p. 2).

Similarly, Herman, Aschbacher, and Winters (1992) determine key elements of assessment:

- Assessment must be congruent with significant instructional goals.
- Assessment must involve the examination of the processes as well as the products of learning.
- Performance-based activities do not constitute assessment per se.
- Cognitive learning theory and its constructivist approach to knowledge acquisition supports the need to integrate assessment methodologies with instruction outcomes and curriculum content.
- An integrated and active view of student learning requires the assessment of holistic and complete performance.
- Assessment design is dependent on assessment purpose: grading and monitoring students' progress are distinct from diagnosis and improvement.
- The key to effective assessment is the match between the task and the intended students' outcomes (p. v-vi).

The third section of the adapted theoretical framework addresses the principles of performance-based assessment in the classroom, as shown in Figure 2.2. The model of assessment developed for this thesis is based on constructivist learning theories, aligned with current science curriculum reform and consistent with contemporary assessment reform. Also, it considers the trend of assessment specialists in which classroom assessment is an integral part of the teaching and learning processes. This section of the thesis follows Shepard's organisation, thus relying on assessment reform rhetoric. I initially discuss performance-based assessment content, then its characteristics, its forms, and finally its use as an integral part of instructional and learning processes.

2.2.3.1 Performance-based assessment addresses learning processes as well as learning outcomes

Current learning and curriculum conceptions, discussed in the first two sections of the framework, serve to shift from traditional assessment methods to performance-based assessment (Herman, 1997; Mislevy, 2004). Herman (1997) argues that if *what you get is what you test*, then the features of alternative assessment reflect the activities endorsed by newer constructivist views of pedagogy. The new assessment method stresses the importance of assessing the processes as well as learning outcomes by assessing students' writing, products, and behaviour (Morrison et al., 2003). It encourages educational practitioners to challenge students to explore the possibilities inherent in open-ended, complex problems, and to draw their own inferences (Herman et al., 1992).

Accongio and Doran (1993) suggest that students are proactively engaged in science, rather than passively absorbing knowledge, that is, it requires students to conduct experiments, investigate natural phenomena, and make products. Science therefore is an apt field for performance assessment (Kind, 1999). Shavelson (1994) concurs, referring to science as the study of active structures and natural phenomena that change frequently. Performance tasks that require students to solve problems in context provide indications of students' thought processes, and understanding; thus emulating the behaviour of scientists.

Performance assessment in science has been related to practical work (Hodson, 1990, 1992), scientific inquiry (Mislevy, 2004; Stecher et al., 2000), hands-on science (Ruiz-Primo et al., 1998), and scientific problem solving (Solano-Flores, 2000). A general approach to assessing scientific skills and abilities depends on investigative and problem solving activities, such as "planning, hypothesising, making measurements, observing, classifying, organising and presenting data, interpreting data, drawing conclusions, and reporting and communicating" (Kind, 1999, p. 2).

However, the use of performance-based assessment to assess scientific processes depends on the definition of processes in relation to skills and other science activities (Gott & Duggan, 2002). For example, Gott and Duggan (2002) and Kind (1996; 1999) discuss alternative approaches for assessing scientific investigation and problem solving. The skills approach to teaching and assessment investigation is a performance model depending on practical activity, and including higher order skills such as planning, observation and measurement, that is, *skills are best learned in the doing* (Gott & Duggan, 2002, p. 185). The second approach stems from the concept of body of knowledge, thus science has a problem solving rather than a descriptive focus. The concept of skill is used to determine the objects and the quality of actions (Gott & Duggan, 2002; Kind, 1996). The UK's Assessment of Performance Unit (APU) model for scientific problem solving activity (1987) is an example of the first approach to performance assessment. The model details the stages of skills students need to solve a problem, and students' skills are tested at each stage. Models represented by Procedural and Conceptual Knowledge in Science (PACKS), and Gott and Duggan, are examples of the second approach. In their approach, Gott and Duggan (2002) suggest that effective problem solving includes an interaction of conceptual and procedural understanding.

Conceptual understanding, as they describe, signifies a knowledge base of fundamental concepts strengthened by scientific facts. Procedural understanding means the thinking behind the doing of science and comprises concepts to guide students, such as choosing how many measurements to take. They also divide understanding into three descriptive levels of cognition similar to Bloom's taxonomy. Kind (2002) argues that performance assessment in science should focus on students' understanding of scientific investigative activity, rather than their problem solving skills. He distinguishes between problem solving that is, using any method for understanding and developing descriptions about natural science; and providing evidence: justifying findings and testing validity.

However, it is important to consider the consequence of the two approaches for performance assessment. According to Gott and Duggan (2002), the skills approach requires extensive training for teachers, and substantial time commitment to the observation of students' actions. The second approach, understanding, emanates from criticism of the skills-based approach, and reflects students' acquisition of various types of knowledge, such as understanding the purpose of an investigation (Kind, 1996, 1999). This in turn leads to a wider range of teaching methods than the first approach, and the associated skills and concepts of evidence, which include practical understanding, can be assessed at different levels and by various formats (Gott & Duggan, 2002).

Baron (1991) asserts that an effective performance task should integrate the big ideas and fundamental concepts, principles and processes in science. If these elements are not well developed then the emerging outcomes will not help the understanding of science (Harlen, 1999). Consistent with these, researchers within the Programme for International Student Assessment [PISA] (1999) developed an assessment framework which involves the following three integrating elements:

I. Scientific processes involve knowledge of scientific concepts. The five processes selected are: recognising scientifically investigable questions, identifying evidence needed in a scientific investigation, drawing or evaluating conclusions, communicating valid conclusions, and demonstrating understanding of scientific concepts (p. 62).

II. Scientific concepts are those which assist in comprehension of aspects of the natural and made worlds. Scientific concepts are expressed at many different levels, under which they are presented in schools, to the long lists of generalisations such as often appear in statements of standards or curricula (p. 63).

III. Situations, in which the issues are presented. The particular situations are known to influence performance, so that it is important to decide and control the range of situations intended for the assessment tasks (p. 65).

However, science standards which rest on the premise that science is an active process, call for more than *science as process* and require high levels of performance. They pose new strategies for performance assessment to assess complex intended learning outcomes that involve the abilities of inquiry, knowledge and understanding of scientific concepts, scientific thinking, utilising scientific knowledge to make personal decisions and to communicate efficiently about science (NRC, 1999).

2.2.3.2 Performance-based assessment involves challenging tasks to elicit higher order thinking

Goodrum, Hackling and Rennie (2001) argue that most traditional assessments are norm referenced where students are allocated a rank order in the population. The weakness of this technique is that the rank shows no relationship to teaching or learning. Criterion referenced forms of assessment are assumed to overcome this weakness by relating performance assessment to criteria linked to learning objects. To efficiently use criterion referenced forms of assessment, desired learning outcomes need to be specified clearly and defined in standards.

Atkin, Black, and Coffey (2001) claim that the goals for science in standard reforms present a significant shift from traditional assessment practice. Standards present science as an active rather than passive subject, focussing on the science content that is important for all students, where students can describe events carefully, reason scientifically, explain natural phenomena, make inquiry, communicate effectively about science and draw conclusions (Atkin et al., 2001; Collins, 1997). For example, standards in the National Research Council (U.S.), (NRC, 1999) detail:

> …present a vision of a scientifically literate populace. They outline what students need to know, understand, and be able to do to be scientifically literate at different grade levels. They describe an educational system in which all students demonstrate high levels of performance, in which teachers are empowered to make the decisions essential for effective learning, in which interlocking communities of teachers and students are focused on learning science, and in which supportive educational programs and systems nurture achievement (p. 2).

Baker (1997) argues that describing standards is not enough to ensure students meet them, and states:

> Describ(ing) those goals will not tell us how well our children are doing unless we also measure their progress in learning the content of these standards. To do this, new kinds of tests are being created, called performance assessments, in which students engage in tasks that may require significant amounts of time (pp. 247-248).

Standards provide substantive reinforcement for science assessment, identifying goals of assessment and the nature of evidence regarding students' understanding or achievements. Traditional assessment procedures are unsatisfactory for complex assessment tasks, whilst performance assessment has resulted in some innovative assessment situations (Mislevy, 2004). Therefore, performance-based assessment has a key role in implementing the science standards reform agenda, focussing on complex thinking and deep understanding, and depending on challenging assessment tasks to determine attainment of standards (Baker, 1997; Herman, 1997).

However, implementing standards not only forces important changes in assessment to be more sophisticated as they have focused on higher-order skills, but also to be authentic considering the real accomplishments that are demonstrated by successful scientists (Newmann, Marks, & Gamoran, 1996a).

2.2.3.3 Authenticity of performance-based assessment

Researchers use varying terminology for assessment: alternative assessment, authentic assessment, and performance-based or performance assessment (Herman et al., 1992). Terwilliger (1998) argues that *performance assessment* is more appropriate than *authentic assessment*, because it is more objective, whereas *authentic* is not relevant in this context. In contrast, Newmann, Brandt, and Wiggins (1998) argue that *performance assessment* is not synonymous with *authentic* because it does not replicate a real world situation. Messick (1994) claims that "constructs of knowledge and skills cannot be assessed directly but rather are inferred from performance and products" (p. 21). The difference, according to Meyer (1992), between performance-based assessment and authentic assessment is that in the former, a student demonstrates the behaviour to be measured; in the latter, a student demonstrates the desired behaviour in a real life context. *Real life* for students can be the classroom, or an adult expectation. However, Cumming and Maxwell (1999) argue that demonstrating a task in the classroom lacks real consequences.

Performance assessment, in the view of Marzano et al. (1993) includes features of both authentic assessment and alternative assessment. Thus, the assessment can be authentic, according to Newmann et al. (1998), if it has meaning or value beyond success in school. Authenticity is, therefore, one of many factors that frame the performance assessment task which obviously appears in many definitions of performance-based assessment.

In their definition of authentic as a feature of performance assessment, Herman, Aschbacher, and Winters (1992) assert: "performance assessment … requires students to actively accomplish complex and significant tasks, while bringing to bear prior knowledge, recent learning, and relevant skills to solve a realistic or authentic problems" (p. 9). Performance assessment, according to

Stiggins and Bridgeford (1982, p. 1), should present a real life situation that can be directly observed:

> Performance assessment is defined as a systematic attempt to measure a learner's ability to use previously acquired knowledge in solving novel problems or completing specific tasks. In performance assessment, real life or simulated assessment exercises are used to elicit original responses which are directly observed and rated by a qualified judge (cited in Wozny, 1998, p. 17).

In 1988, the term *authentic* was related to achievement by Archbald and Newmann (Chang & Chiu, 2005), and a year later, the term *authentic assessment* was used by Grant Wiggins. Cumming and Maxwell (1999) believe this transferred description is normal as the attention has been payed not only to appropriate learning but also to the manner of how it is to be recognised, they argue that:

> Assessment of authentic achievement' places an emphasis on the nature of the achievement… whereas 'authentic assessment of achievement' places an emphasis on the manner of assessment and could leave the nature of the achievement itself unexamined (Cumming & Maxwell, 1999, p. 179).

According to Wiggins (1990) authentic assessment evaluates student performance on intellectual tasks. Wiggins suggests that authentic assessment should: require students to be active performers, producing a quality product or performance; present students with tasks that mirror the priorities and challenges encountered in real life; gauge whether the student can craft polished, thorough and justifiable answers, performances or products; and involve 'ill-structured' challenges and roles that assist students to prepare for the complex ambiguities of the professional life.

The term authentic assessment means that assessment tasks are examples of expended performances, rather than estimators of actual learning objectives (Henderson & Karr-Kidwell, 1998). Andrade (1999) states that assessment becomes authentic when it demonstrates the real-life performances and challenges practised by real practitioners in the field. However, authentic assessments should be linked to the curriculum, occur in intellectual challenge, and connect to the world beyond the classroom (Andrade, 1999; Noori, 1993). Indeed, this form of assessment is relevant to curricula for high-ability students as well as curricula that focus on higher level thinking (Moon, Brighton, Callahan, & Robinson, 2005). With authentic assessment methods, students perceive the learning process as important and related to skills used in the real world (Lines, 1994). Also, it is about purposeful teaching in the direction of experiences that are useful, reasonable and real, and in which the student is an active learner and creator of knowledge and skills that are structured around meaningful contexts (Miller & Singleton, 1997).

Authentic assessment tasks can take several forms: presentations, projects, group work, problem solving activities, debating, and to make choices about their learning (Moon et al., 2005; Peatling, 2000). In addition, Smith, Layng, and Jones (1996) consider anecdotal recorders, journals, portfolios and interviews are important forms of authentic assessment, and view observation of student performance as a key component to increasing the effectiveness of authentic assessment.

Cumming and Maxwell (1999) argue that authentic assessment requires attention to authentic achievement. The researchers conclude there is a dynamic relationship between the four components: learning goals, teaching activities, learning processes, and assessment procedures, modification of one component has an effect on the remainder. Further, based on the fact that different theoretical interpretation lead to variations in the constructions of authenticity and the employment of authentic assessment, Cumming and Maxwell (1999) point out four components, which are:

- performance assessment, which assesses a given process through actual demonstration,
- situated learning and situated assessment, which assesses performance within the relevant learning context,
- complexity of expertise and problem-based assessment, which concerns the real performance that goes beyond technical facility, and
- competence and competence-based assessment, which assesses particular skills related to work sector.

Consistent with Cumming and Maxwell's (1999) theory, Chang and Chiu (2005; 1999) developed an authentic assessment project. The project involved six levels of scientific literacy: scientific cognition, process skills, application of science, habits of mind, nature of science, and attitudes toward science. After implementing the project for two years, they found that authentic assessment was more successful in evaluating students' abilities in science than standardised tests. Further, Newmann, Bryk, and Nagaoka (2001) reported results from a substantial study of classroom writing and mathematics assignments given in grades 3, 6, and 8, rating assignments for authentic intellectual activity. The study shows that students who received assignments requiring more challenging intellectual work, achieved greater than average gains on the Iowa Test of Basic Skills in reading and mathematics and demonstrated higher performance in reading, mathematics, and writing, on the Illinois Goals Assessment Program.

Although authentic assessment is widely accepted by researchers and educators, debate ensues regarding its features and implementation (Chang & Chiu, 2005; Cumming & Maxwell, 1999; Moon et al., 2005). Factors such as *camouflage* and *simulation* were raised by Cumming and Maxwell (1999). Camouflage occurs in different cases when conventional assessment forms are ‘dressed up’ to appear authentic, or when authentic assessment is implemented in varying degrees of sophistication and types of camouflage. To clarify these ideas, they present the following example: “Toula and Roula each buy a new book. Toula’s book has 450 pages and Roula’s book has 280 pages. If Toula reads 50 pages per day and Roula reads 40 pages per day, who will finish their book first?” (p188). Cumming and Maxwell (1999) argued that Toula and Roula are well-known names in an Australian television comedy show, but their insertion does not change the context of the problem or offer a degree of clarity that facilitates a solution. In addition, the authors argue that simulation of the *real world* has replaced the original concept of authenticity; tasks are not actually *real*, especially if they are conducted in the classroom.

2.2.3.4 Tools and forms of performance-based assessment

According to Shepard (2000b) recent educational reforms identify different forms of performance-based assessment to facilitate students’ mastery of science skills, to think critically, to solve complex problems, and to use their knowledge in life situations. She argues that if instructional goals include promoting students' metacognitive ability, encouraging important behaviours, and socialising students into academic language and practices, then it is essential that classroom practices and assessment reflect these goals as well. Further, if assessment procedures take into account students' individual differences, then assessment tools need to be flexible to meet these criteria. Performance assessment tasks enable assessment of the answering process a student employs, which are learning activities standardised through accurate development to ensure their use as measurement tools (Brown; & Shavelson, 1996; Century, 2002). Shepard (2000b) proposes these tasks should be part of instructional procedures and consequently include *observation-based assessment*, which involves a balance of formal and informal classroom assessment, and in later classes, students can participate in developing assessment activities.

In another form of assessment, students conduct a project. This is an in-depth investigation of a variety of topics which requires a wide range of competencies, student initiative and creativity (Katz & Chard, 1998; Rudner; & Boston, 1994). Examples include a demonstration, a live performance, competition, or a collaborative activity that students work on over time. This assessment project is a research attempt by students to find answers on a particular topic by applying their skills, developing their proficiencies and self motivation, and achieving self-reliance for their needs (Katz, 1998). A project approach to performance assessment meets educational standards reform that sets high expectations for students' achievement, engaging learners in challenging and authentic tasks, and uses strategic and collaborative strategies in their learning (Helm, 1998). Several empirical studies on the project approach (Chard, 2000; Elliott, 2000; Helm, 2003; Yun, 2000) indicate that introducing projects into a curriculum meet features recommended by educational reform. Learners become responsible for their learning, take on active rather than passive roles, plan in-depth investigations, and develop different skills such as experimenting, and presenting their findings.

A portfolio is another form of performance assessment that has broad acceptance as a learning and assessment tool (Hall & Hewitt-Gervais, 2000). “A portfolio is a purposeful collection of a student’s work that exhibits the student’s efforts, progress, and achievement in one or more areas” (Jorgensen, 1994, p. 13). As an external tool, portfolios can be used to document students’ work in relation to external evaluation requirements because of their situated and context-rich nature (Tillema, 2003b). However, Shepard (2000b) claims that the use of portfolios for accountability assessment lacks reliability and fairness, and prefers their use in a classroom for teaching and learning purposes. She argues that a preferable approach is the creation of portfolio structures to learn from student work and for the portfolio to be a part of instructional procedures.

Hall and Hewitt-Gervais (2000) argue that teachers vary significantly in their approach to portfolio design, and implementation, ranging from portfolios being a feature of instructional activities to merely being folders holding papers. To use portfolios effectively, Bonnie Jones (in interview with Walther-Thomas and Brownell, 2001) suggests four aspects for teachers’ consideration when developing portfolios:

- how the portfolios' activities align with content standards for the subject matter.
- giving students opportunity to develop their portfolios and reflect on their learning.
- students must include manifold products in the portfolio to show what they have learned and mastered.
- making a plan to evaluate student work and discuss work sample with each student.

Jones concluded that if portfolio assessment is added to existing work for teachers, it is unlikely to be effective (Walther-Thomas & Brownell, 2001).

Portfolios are a process approach to learning that highlight the growth of student understanding (Hall & Hewitt-Gervais, 2000). In a literature review, the authors summarise the advantages of using portfolios as:

- an authentic assessment of students' learning.
- promoting student reflection and self-evaluation.
- facilitating three-way communication between teachers, students, and parents; and encouraging students to take charge of their own learning (pp. 210-211).

Using portfolios in the classroom "can provide an organising structure for teacher-students critiques and self-reflections" (Shepard, 2000b, p. 45). The tool improves instruction and assessment, supports the educator's interest in authentic assessment, documents students' progress, and encourages co-operation between teachers and students (Valencia & Calfee, 1991). Tillema and Smith (2000) found that portfolios can be successful tools for assessing student learning outcomes as well as for informative purposes to give insight into students' accomplishments. As an intervention, the portfolio's strongest benefit is in its ability to provide insight into students' performance and to track their accomplishments. For Tillema and Smith, the most important feature of portfolios may be that they give students control over their own learning by helping them to recognise the strengths and weaknesses in their development and that their effect is both continuous and non-threatening. Hall and Hewitt-Gervais (2000) reveal that the majority of teachers who were interviewed about the effectiveness of student portfolios noted a positive effect on students' endeavour and motivation. This effectiveness was based on the students' consciousness that their parents and teachers would look at their work.

Experiments are another dimension of performance assessment used in science curricula. An experiment can assess a student's understanding of scientific concepts, and processes. Such assessment activities encourage activities in science such as planning, undertaking activities, drawing hypotheses, measuring, and applying scientific facts and concepts (Rudner; & Boston, 1994).

A presentation is also considered an important form of performance assessment. It serves as a culminating activity (Jones, 2001). A presentation involves students in a variety of activities that are both process- and product-oriented (Saskatchewan Education, 1991). In doing presentations, students prepare, practise, and then present their work to their class and teachers. The presentations themselves allow students to interact and communicate with others (Brooks, 1999). Jones (2001) assumes that in presentation and exhibitions, students present and defend their learning and performance in relation to the established criteria of quality.

As noted, there are many forms of performance-based assessment some generic and some purpose-specific. Learning goals involving different levels of knowledge and skills require a variety of assessment forms. Advocates of balanced performance assessment (Herman et al., 1992; Shepard, 2000b) believe that all formats including traditional tests are necessary to reflect assessment data and to ensure complementary assessment tools that evaluate complex performance through using scoring rubrics and formats that measure certain kinds of knowledge.

2.2.3.5 Rubrics of performance-based assessment

The information gathered by performance assessment is of limited use if it "cannot be communicated, aggregated, or tracked in a concise manner" (Jorgensen, 1994, p. 47). Techniques for scoring criteria, therefore, assess science content as well as processes (Demers, 2000; Finson & Ormsbee, 1998; Moskal, 2003b; Perlman, 2003; Shepard, 2000b). Herman (1992) asserts that, to judge the process and quality of a complex response, a well conceived, unambiguously defined, and constantly applied scoring rubric is needed.

A rubric is "a type of scoring guide used to assess more complex, subjective criteria" (Rose, 1999, p. 1). It is an instrument for organising and interpreting data gathered from observation of student performance. More accurately, it is a scoring guide that distinguishes between levels of development in a particular area of performance or behaviour (Rose, 1999). Typically, rubrics are used when a judgment of quality is needed and may be used to assess a broad range of activities (Moskal, 2003a). They are a device for transforming student behaviour to numerical scores or category descriptions (Jorgensen, 1994). Rubrics differ from a checklist that simply lists the criteria for assignments in that they describe desirable qualities as well as common difficulties in students' work (Andrade, 2005).

The two rubrics used in performance-based assessment are analytic and holistic. Analytic rubrics are used to score specific responses on different dimensions of the task, with scores from each dimension totalled to determine student performance (Jorgensen, 1994; Moskal, 2003a). Teachers using analytic rubrics evaluate each student response, and score it according to established criteria; allowing for little subjectivity (Finson & Ormsbee, 1998). Holistic rubrics, on the other hand, assess the overall quality of a student's response and thus permit broader judgments of the quality of a process or product (Finson & Ormsbee, 1998). In both kinds of rubrics, criteria for levels of performance are established by expert educators (Jorgensen, 1994). Criteria should reflect the highest priority instructional goals, and represent teachable, and observable aspects of performance (Herman, 1992). Finson and Ormsbee (1998) believe an analytic rubric is appropriate for learners who have special educational needs. These learners can obtain some scores for the process skills required to complete the task rather than merely being restricted to the product itself. However, they also suggest that analytic and holistic rubrics can be used together, as they evaluate different sides of a given task. The first evaluates the process and the second the product.

Andrade (2005) distinguishes between two kinds of rubrics. A scoring rubric is used exclusively by teachers to assign grades and an instructional rubric designed with students, handed out, used to facilitate self-assessment, encourage teacher feedback, and then employed to establish grades. Instructional rubrics differ from traditional assessment methods in that they evaluate students in the authentic process of learning, illustrating clearly to them how their performance is being assessed (Rose, 1999). Andrade (2000, 2005) states that instructional rubrics clarify teachers' expectations and help students to understand an assignment's goals so as to focus effort. In addition, instructional rubrics provide students with informative feedback about strengths and weaknesses in their performance. Shepard (2000b) asserts that rubrics give feedback to students and thus assist in self-assessment. This was confirmed in an investigation of the effects of rubrics and self-assessment on learning, by Andrade (2000), who concluded that self-assessment encouraged by a rubric was linked to an improvement in learning.

Although widely accepted in principle, there are concerns about the use of rubrics. Popham (1997) claims that the majority of rubrics are instructionally fraudulent. For example, narrowing criteria to measure a skill to specific elements of a performance task, rather than embracing the instructionally relevant components of the rubric. Another example is excessively generic criteria, which offers teachers little guidance on the key elements, and do not define genuinely significant factors in a student's response. Andrade (2005) notes that rubrics are not a replacement for good instruction. Teachers need to master rubrics to improve teaching and learning. "Anyone can download a rubric from the Web, but using it to support good instruction is another matter" (p. 29). Schafer (2001) found that the achievement of students whose teachers received rubric training was better than students whose teachers did not. Andrade (2000, 2005) found that rubrics are not entirely self-explanatory, and students need assistance in understanding the tool and its use. She also suggests that rubrics elicited different responses from students such as causing concern with motivated students, and disinterest from others.

2.2.3.6 Using performance-based assessment formatively in support of student learning

As performance-based assessment activities and tasks allow students to display their performance in different ways, and as the intention of assessment is to improve learning, performance assessment has the potential to provide formative assessment feedback (Goodrum et al., 2001). Formative assessment is a type of assessment distinguished from summative assessment the latter being used for reporting and grading (Carr et al., 2003). According to King (2003), the research factors for increased interest in formative assessment are:

- invigorated focus on classroom-based assessment by teachers,
- use of assessment data for multiple functions, such as curriculum evaluation, evaluation of teachers, and measuring the effectiveness of instructional programs, and
- integration of constructivist approaches in science instruction, with an emphasis on teaching for conceptual understanding.

Black and William (1998a) define formative assessment as “encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged” (p. 2). They state that the core of activity depends on two actions. Firstly, awareness by the student of the gap between a current result, and an intended goal. Secondly, the action taken by the student to close that gap and achieve the goal. Black and William suggest that teachers can give students the opportunity to recognise gaps and the responsibility to correct them, or they can alert the student to monitor subsequent activity, or indeed use a combination of both approaches.

Formative assessment can be formal or informal (Bell & Cowie, 1997; Dixon & Williams, 2003). Formal formative assessment involves planned instruments to provide information about students' progress. In contrast, informal formative assessment is embedded in the teaching and learning activities as the teacher works with small groups or individuals (Dixon & Williams, 2003). Each type serves a different purpose. Formal formative assessment focuses on obtaining information from the whole class (Ruiz-Primo & Furtak, 2004). The information enables teachers to find out students' prior knowledge, check students' understanding and then reflect on the next step (Cowie & Bell, 1999). It can take many forms, such as observing particular aspects of learning, conducting quizzes, brainstorming and asking direct questions. Informal formative assessment may occur at any time during interaction between a teacher and students (Bell & Cowie, 2000). It highlights individual students' needs at the time, so teachers can respond with appropriate reaction that scaffolds the next step of learning (Ruiz-Primo & Furtak, 2004).

Formative classroom assessment can be applied, according to Guskey (2005) using the Bloom-based strategy of *mastery learning* to guide teachers in differentiating instruction. With this strategy, teachers organise learning concepts and skills for week-long instructional units. Following an initial instruction on the unit, teachers run a brief *formative* assessment, based on the unit's learning goals. This formative assessment's aim is to provide students with information, or feedback, on their learning processes. Paired with each formative assessment are specific corrective activities for students' learning difficulties. On completion of this stage, Bloom recommends the students have a second formative assessment, covering the same concepts and skills, but composed of slightly different problems or questions. This second stage verifies that the correctives were applied successfully, and, as it offers students a second chance at success, there is a powerful motivational value. Finally, to ensure their continued learning progress, Bloom recommends these students be provided with *enrichment* or *extension* activities to broaden their learning experiences.

There are three questions that guide the planning and implementation of formative assessment in the science classroom (NRC, 2001):

1. What learning and performance goals are established?
2. What is the current level of student understanding?
3. How can students attain the skills and strategies needed to reach the goals that have been identified?

A model of classroom assessment presented by Torrance and Pryor (2001) involves divergent assessment, based on social constructivist principles to identify the extent of the learner's comprehension of a topic. Divergent assessment is characterised by flexible planning, open forms of recording, open questions and tasks, and involvement of the student in the assessment process.

Teachers' use of assessment information for feedback on students' science knowledge, skills and needs to inform, and improve student learning, is the essence of formative assessment (Bell & Cowie, 2000). The quality of this feedback is a key component of any procedure for classroom assessment (Sadler, 1998). Black and William (1998A) determine feedback through four components;

(1) data on the actual level of some measurable attribute,
(2) data on the reference level of that attribute,
(3) a mechanism for comparing the two levels,
(4) generating information about the gap between the two levels.

However, Kluger and DeNisi (1996) consider the first element as the main component of feedback. Ramaprasad (1983) specified feedback as components 3 and 4, whereas Atkin, Black, and Coffey (2001) and Black and William(1998a) stress that no feedback can exist without using the information to alter the gap between the two levels. Reviews of research (Black & William, 1998b; Crooks, 1988) show positive effects of feedback on students' learning, beliefs and attitudes toward science. King (2003) conducted a quasi-experimental study investigating the effects of formative assessment with reflection on students' motivational beliefs, self-regulatory skills, and achievement in elementary science. The study results reveal that students had positive attitudes toward science, high levels of self-efficacy in science, and students believed formative assessment with reflection was beneficial for science learning outcomes.

Evera (2004) investigated the effects of information-rich formative assessment feedback on performance, and motivation of middle school science students. The researcher used written formative assessment feedback on all assignments with an application group, and final scores but no feedback for a control group. Results indicate that there were significant benefits for middle and low achievers in the treatment group as they performed better in the science classroom and experienced a significant increase in self-efficacy.

However, Black et al. (2004) assert that there is no particular recipe for improvement outcomes in classroom assessment practice, but there are factors such as the kind of learning tasks, quality of questions, the orientation of feedback on oral and written work, and student self-assessment. More importantly, the learning environment should allow students to participate in a constructivist learning environment, construct their own meaning of knowledge based upon the social and cultural perspective of a learning position (Graue, 1993; Shepard, 2000a).

2.2.3.7 Enabling students to be active in evaluating their own work

Student self-assessment has received considerable attention within studies undertaken in the last decade (Andrade, 1999; Lee & Gavine, 2003; Olina & Sullivan, 2002; Peatling, 2000; Towler & Broadfoot, 1992; Woodward, 2003). Several researchers have argued that student self-assessment has the potential to improve student achievement (Black & William, 1998a; Orsmond, Merry, & Callaghan, 2004; Trotman, 1998). Nevertheless, self-assessment by students is not common practice and is often overlooked in general literature on classroom assessment (Black & William, 1998a).

Involving students in the assessment process reflects constructive learning theory which asserts that meaningful learning happens when learners are actively engaged in constructing and developing their understanding (Peatling, 2000). Student contribution is a key component of successful assessment strategies at every stage, and students need clear goals and the criteria to assess their efforts, and, through feedback, share responsibility for their work (Atkin et al., 2001). Lee and Gavine (2003) claim that the current emphasis on target-setting and metacognition generates opportunities for students to assess themselves. Others (Peatling, 2000; Towler & Broadfoot, 1992) look further than this and argue that students are better motivated if able to articulate their needs for learning and encouraged, through discussion and negotiation, to work with teachers to set assessment goals, performance criteria and the rubrics for scoring tasks. Peatling (2000) finds that student involvement in the assessment process is in the formulation of academic and social learning goals, including the development of assessment tasks, and assessment criteria; and self-assessment, and self-reflection on the learning process. Sadler (1998) suggests that most processes and resources that are thought to be natural and normal for teachers need to be simulated for the students and built into their environment.

Self-assessment is defined as: “a process by which a learner is empowered to make explicit judgments about the achievement of, or progress towards, curricular goals” (Lee & Gavine, 2003, p. 50), and involves both self-evaluation and self-awareness (Trotman, 1998). After reviewing several studies Andrade (1999) concludes that self-assessment is a key component of metacognition, or evaluating one’s thought processes. However, Lee and Gavine (2003) argue that self-evaluation refers to psychological rather than curriculum domains and that self-assessment has a strong relationship with more general concepts such as metacognition and self-regulation, discussed earlier (See s2.2.1.4).

Self-assessment in performance-based assessment comprises tools such as discussion, checklists and interviews (Trotman, 1998). For example, Olina and Sullivan (2002) designed a self-assessment form similar to that used by teachers. The students then applied the Rating Scale to evaluate their written reports and to write comments about their work and they also had opportunities to revise their work in their final reports. Paris and Ayres (1994) developed a portfolio approach to literacy assessment based on student self-evaluations and self-assessment. The approach has different tools for reflection, including the process of collecting of materials for inserting in the portfolios, global self-evaluations, inventories, survey, journals, self-portraits, letters, and conferences.

Self-assessment assists students to gauge the quality of their performance and the manner of execution (Andrade, 1999). Ideally, self-assessment serves social and motivational targets as well as improving cognitive performance. Student debates about standards and reflection on their work enhance a collaborative relationship to learning and thus students’ science achievements. Involving students in the assessment process engages them in making judgments, through decisions on elements and criteria for assessment which is of benefit to each individual (Shepard, 2000b). In addition, through reflection on their progress, self-assessment assists individuals to be active and independent learners (Peatling, 2000). Indeed, “it will enhance relationships between teachers and students when students begin to see themselves as partners in the assessment process rather than the 'victims' of it" (Peatling, 2000, p. 13); and this prompts Sadler (1998) to suggest that curricula should contain self-assessment. Self-assessment allows children to make sense of their experiences, teaching them to become life-long learners, and is a vital part of any assessment method (Towler & Broadfoot, 1992). Trotman (1998) noted that self-assessment "gives students a sense of ownership and control of what they need to learn, an appreciation of what they have actually learned, together with an understanding of why they have learned" (p. 2). The researcher continued, that self-assessment encourages a better quality of learning by "(i) affording many opportunities for students to learn and communicate about mathematics, and (ii) directly involving those who are affected the most" (p. 13).

As discussed, self-assessment has beneficial effects on students' awareness, motivation, and involvement in their work. To investigate these effects, Olina and Sullivan(2002) conducted a student and teacher study involving three groups: first, no assessment; second, teacher assessment; and third, both self assessment, and teacher assessment. The results show that students in the second and third groups had significantly higher ratings on their projects, whereas the no-assessment group had more favourable attitudes toward the program than the other groups. However, the third, double assessment, group was significantly more confident in their work.

Trotman (1998) reported that self-assessing students were participatory, conscientious, and successful learners, able to generalise their learning into new areas. Further, these students viewed assessment as measuring their successes, strengths and weaknesses, rather than as a learning end point. Peatling (2000) conducted a collaborative study for students and teachers producing assessment criteria, and scoring rubrics; the latter used by teachers and students for both self and peer assessment. The study found that teaching and learning are enhanced by peer and self-assessment and reflection tools; however, the process is lengthy and difficult, particularly at first.

2.2.3.8 Integrating performance-based assessment with science instruction

Shacklock (2006) asserts that recent educational reform has emphasised the link between curriculum, teaching and performance assessment to improve learner engagement through response to learner diversity and connect to the real life of students. Integrating performance-based assessment with instruction to provide a learning opportunity for both students and teachers requires a considerable change in instructional procedures. Traditionally, assessment, and instruction are considered as separate activities in both time and purpose, as assessment is used judgmentally rather than as a tool for learning (Even, 2004; Graue, 1993). The traditional perspectives are based on learning theory as a mechanistic process of breaking knowledge into elements for students to absorb and memorise (Pilcher, 2001).

In addition, instructional procedures being directed by traditional test perspectives and pedagogical beliefs lead to direct instruction that may not result in effective learning outcomes (Jones, 2001). Traditional achievement tests, as some studies (Frederikesn, 1994) indicate, comprise assessing tasks requiring recall of factual knowledge rather than higher order thinking. This approach, where the teacher takes the active role of knowledge sender, and students take a passive role of knowledge receivers, gives students few opportunities to master, and display the type of complex higher order thinking needed in the real world (Jones, 2001).

To enable performance assessment to positively affect learning and enhance instructional procedure, a link between classroom assessment and teaching processes is required. Wiggins (1998) states that “once assessment is designed to be educative, it is no longer separate from instruction; it is a major, essential, and integrated part of teaching and learning” (p. 8). One goal of performance-based assessment is for teachers’ instructional procedures to incorporate better integrated, more complex learning activities, with greater generalisation to real-life problems (Fuchs, 1994).

Further, to successfully integrate performance assessment with instruction, a constructive classroom environment is required (Even, 2004; Graue, 1993; Keogh & Naylor, 1996). In a constructive learning environment students assemble knowledge in a manner that reflects their social and cultural learning context (Graue 1993), thus aligning with science educators who view science as related to social, political, economic and ethical issues: a product of its time and place (Hodson, 2003; 1998). Teaching methods, therefore, have an emphasis on active learning opportunities for students, and the use of performance assessment for teachers to evaluate instructional practices (Hodson, 2003). Thus reform must occur to replace dominant traditional perspectives which continue to drive dysfunctional instructional and assessment practices; and beliefs of teachers (Graue, 1993; Shepard, 2000a). Pilcher (2001), when designing an instructional assessment plan with teachers, reported that they were apprehensive about the subjectivity of performance assessment, believing that they randomly evaluate students' performance implementing an assessment rubric. The teachers preferred the certainty of objectivity.

For assessment and curriculum reformers, therefore, blending assessment and instruction requires a shift in traditional classroom techniques (Even, 2004). Pilcher (2001) argues there is insufficient teacher preparedness to successfully apply instructional assessment processes in a social constructivist learning environment. Whilst taking into account their duties and circumstances, teachers should be professionally trained and supported (see Chapter 3).

As a response to current educational reform efforts, several theoretical and empirical frameworks to integrate assessment and instruction are extant (Barron et al., 1998; Dochy et al., 1996; Even, 2004). Based on a social constructivist approach, Graue (1993) described an instructional assessment framework to integrate assessment with instruction. The framework grounds authentic learning in the classroom; aligning assessment, and instruction to inform each other, Graue proposes that:

> By interweaving assessment and instruction and by working toward authentic achievement, we can heighten the attention and value placed on instructional practice as an information source. We need to aim for the development of instructional activities that have two interrelated purposes: the development of authentic learning and generating of evidence of that learning (p. 293).

Alignment of assessment with both the aims of instruction, and the content of the curriculum, is a key aspect of instructional assessment (Bliem & Davinroy, 1997; Graue, 1993; Pilcher, 2001). When introducing performance-based assessment, existing curriculum materials may need adaptation or replacement activities that match formats of instruction, and also match classroom processes (Graue, 1993; Jones, 2001). When performance assessments are aligned with curriculum, this element, curriculum, is the standard against which an assessment tool should be evaluated (Graue, 1993). As an integrated part of instruction, assessment tasks emerge from ongoing classwork rather than from external sources (Jones, 2001). Fuchs (1994) proffers criteria for integrating performance assessment with instruction:

- measures important learning outcomes
- addresses assessment purposes (instructional placement, formative evaluation and diagnosis)
- provides clear descriptions of student performance linked to instructional actions
- compatible with a variety of instructional models
- feasible (easily administered, scored, and interpreted by teachers)
- communicates the goals of learning to teachers and students
- generates accurate, meaningful information (pp. 3-6).

Frameworks generally integrate steps to link assessment and instruction. As an example, Nitko (1989) recommends that instructional outcomes of behaviours and cognitive processes are measured by assessment practices; tests formulated to encourage students to keep learning; and facilitative feedback used in assessment processes (Dochy et al., 1996). Graue (1993) has similar steps for the integration assessment and instruction: identify the knowledge and skills goals and their application from both assessment and instructional viewpoints; then for assessment objectives, reconfirm the significance of information gained from instructional activities. There are, however, differences in these approaches, as Nitko's suggestions draw on traditional perspectives, where instructional processes and assessment practices occur at different times, and the results of tests can be used for instructional decisions. Graue's framework is aligned with educational perspectives of social constructivist and alternative assessment; and in Graue's model, the outcome information generated can be used for both assessment and instruction, which are viewed as one process.

Performance assessment aligns with the constructivist approach that analysis, synthesis, and evaluation are largely cooperative procedures focussing on personal learning skills, using prior knowledge, and engaging in activities related to a problem or task (Howell et al., 1999). According to Shepard (2000a) other performance assessment forms that directly connect assessment to instruction are necessary to enable students to undertake higher order learning goals, and to take responsibility for their learning. In this approach, the teacher's role ranges from developing performance assessment activities to complement learning activities to professional knowledge for understanding the meaning of a student performance. Decisions are intrinsically tied to the teacher's view of content and pedagogy; making judgments about classroom activity, monitoring individuals and their interactions (Graue, 1993). In performance assessment approaches, students have a role in integrating assessment and instruction, a student is "an active constructor of knowledge ...participation in learning, premised on the ides of authenticity .. active engagement in generating information about that learning… would take responsibility for understanding and communicating their learning" (Graue, 1993, p. 296).

Using assessment strategies that link to instructional processes provides students with constant feedback, allowing evaluation of their learning before completing the final product, and therefore attaining expected levels of expertise (Pilcher, 2001). Student learning occurs through self-assessment, or by modification of instructional procedures with teacher assistance to suit individual needs (Even, 2004). This latter strategy of providing assessment assistance, allows a teacher insight to expand understanding, generates targeted occasions to teach, and supports future learning steps (Shepard, 2000a). Further benefits of integrating instruction with assessment, through enhanced feedback, are a rise in student enthusiasm for learning; opportune notice of students' learning improvements or difficulties faced; instruction efficiency is accurately assessed (Fuchs, 1994).

Other studies examine the effects of linking assessment to instruction. Fuchs, Fuchs, Karns, Hamlett, and Katzaroff (1999) undertook such a study where results showed that classroom-based performance assessment improved instructional decisions, and teachers used varied strategies to promote problem solving. Compared to traditional approaches, above grade students under performance assessment showed stronger problem solving on all measures. A study by Graue and Smith (1996) examining the effect of new forms of curricula on assessment practice, however, conclude that "thinking about assessment from an instructional perspective is a complex, rich, and confusing enterprise" (p. 135). And therefore, innovative assessment strategies cannot depend on new curricula alone. Assessment strategies develop over time, as situations emerge that motivate teachers to consider new methods of instructional activity. In another study, Even (2004) used a framework involving three dimensions: degree of integration of assessment with instruction; methods and tools used for assessment; and purposes of assessment; to examine issues arising from such assessment. The results raise concerns regarding teachers' capacity to accurately interpret students' performance in the classroom: teachers use new assessment instruments to serve traditional assessment purposes, such as grading students at the end of instruction, rather than the use of rich information to make instructional decisions and improve students' learning.

2.2.4 Summary

This section presents a brief historical perspective about science curriculum reforms over the last 60 years in relation to assessment practices, and then focuses on an adapted conceptual framework of classroom assessment. The framework was developed by Shepard (1997) in order to support teaching and learning based on a constructivist perspective. I adapted it for using performance-based assessment in the primary science classroom. The framework comprises a three part figure built to emphasise contemporary changes in learning theory, curricula and assessment. The first part highlights the main principles of cognitive and constructivist learning theories. Learning and understanding are considered to be essentially socio-cultural activities (Shepard, 2000a; 2000b): they happen through the social environment where children interact with adults who provide both a model of knowledge and an occasion for guided practice (Shepard, 2000b). They can also be developed and employed by collaborating groups where students employ an active role in acquiring and using knowledge in authentic learning situations (Palincsar, 1998; Roelofs & Houtveen, 1998; Roth, 1995). Working cooperatively in groups promotes a shared sense of community, as well as higher order thinking particularly when the learners are provided with the tools to interactively engage in high-level discussions that lead to greater theoretical understanding (Johnson & Johnson, 1989; Millis, 2002). However, the results of interaction and understanding processes are affected by prior knowledge and cultural perspectives that are characteristically flowing and dynamic (Dochy, 1991). Learners use their previous experience when learning new ideas, they are aware of the ideas during the interpretation of activities, and incessantly and intentionally scrutinise their developing understanding as they are attempting to learn or use new experiences by different strategies (Mason & Santi, 1994). However, Shepard (2000b) claims that learners may not employ the strategies they know unless they are motivated to do so. As motivation is important for social-cognitive processes, motivational theories have suggested various motivational models that emphasise five major elements: goals orientation, self-efficacy, attributions, interest, and values (Mason & Santi, 1994). Attitudes also emerge as an essential component in students' learning; it is assumed that low positive attitudes lead to little chance of learning proficiently (Marzano et al., 1993). In general, the most important idea in this part of the framework is that learning and development are primarily social processes (Shepard, 2000a).

The principles of learning theory lead to a set of perspectives for science curriculum and classroom assessment. The "science for all" commitment refutes the attitude that limited the opportunity of learning to elite students, and requires providing equal opportunity for students (Shepard, 2000a; 2000b). In order to achieve the goal of “science for all”, the standards must identify criteria for high-quality science practices that comprise the engagement of all students in the wide range of science content (Hoffman & Stage, 1993). This challenged science educators to implement dramatic change in teaching and learning science. Most standard reforms endorse using inquiry, where students are actively engaged in both science processes and critical thinking skills as they seek answer to their own questions (Gibson & Chase, 2002). Most contemporary science curricula put considerable emphasis on the nature of scientific inquiry and the complex relationships among science, technology, society, and the real world beyond school (Bencze & Hodson, 1998). Connecting learning science to everyday life issues and teaching it through sociocultural theories brings about increasing recognition among science educators that science is a product of its time and place, inextricably linked with its sociocultural and institutional location, and deeply influenced by its methods of generation and validation (Hodson, 2004). Moreover, scientific habits of mind are an integral part of contemporary descriptions of scientific literacy (Volkmann & Eichinger, 1999). Within curricula developed around broad outcomes and that focus on continuing, transdisciplinary learning, students give meaning to their learning (Costa & Kallick, 2000b). In general, this part discusses the concept of learning “science for all” at high quality performance standards that allow students to use their abilities and skills in real-world contexts.

Performance–based assessment as shown in the third part of the theoretical paradigm reflects how the new concepts of cognitive and constructivist learning theories have been implemented in the classroom, and how to serve the vision of science curriculum reforms. It links instructional procedures more tightly to students' learning progress by stressing the importance of assessing both the processes and the learning outcomes (Morrison et al., 2003). It also aligns with standard-based reform, if standards are defined as *what students should know, understand, and be able to do* (Kansas State Board of Education Standards, 2001, p. 10), performance assessment also aims to provide impetus for increasing students' understanding of what they need to know and be able to do (Sweet, 1993). Moreover, performance assessment can be used not only to apply standard reforms in a science classroom but also to help accomplish high-quality science practices that will engage all students in the wide range of science content that requires students to reason, solve problems and apply their knowledge to real life situations (Hoffman & Stage, 1993; Shepard, 2000a). In addition, performance assessment, through its forms and techniques, develops a wide range of students' abilities and skills, supports metacognitive abilities, enhances important dispositions, and socialises students into the discourse and practices of science (Shepard, 2000a). It is also compatible with principles of assessment for learning (Black et al., 2004; Chappuis & Stiggins, 2002) once teachers are able to use it formatively.

CHAPTER 3: PERFORMANCE-BASED ASSESSMENT IMPLEMENTATION AND OUTCOMES

The subject of professional development for teachers so that they can adequately implement performance assessment in a science classroom is discussed in this chapter. The dimensions for professional development include knowledge, required skills, barriers to teachers' professional development, and features of an effective professional development program. This chapter also includes a review of empirical studies regarding the development of teacher proficiency in designing and implementing performance-based assessment, and the effects of performance-based assessment on student learning and student attitude toward science.

3.1 Science teachers' requirements for implementing performance-based assessment

The ongoing revision of learning, assessment and teaching concepts underlying educational reform in science places profound demands on teachers. The restructured methodologies call for new participating roles for teachers that are as professionally demanding as the concepts they explore for their students. This complex role extends from the development of assessment tasks to achieve student learning standards to the application of expert knowledge to interpret student performance. Thus professional development for science teachers is recognised as a vital component to enhance the quality of teaching, assessment, and learning in school science (Akerson et al., 2002; Borko, Mayfield, Marion, Flexer, & Cumbo, 1997; Dass, 2001a; Ingvarson, Meiers, & Beavis, 2005).

This growing realisation of the importance of professional development of science teachers is based upon statements such as " Equity in education is fundamentally about ensuring every student has a quality teacher, well educated in the particular subject area and well trained to teach it" (Ingvarson & Wright, 1999, p. 3), and "Nothing is more central to student learning than the quality of the teacher" (Galluzzo, 2005, p. 142). Results of the Strauss and Sawyer (1986) seminal study on teacher and student competencies showed that each one per cent increase in teacher quality, measured by standardised test scores, directly correlated with a five per cent decline in student failure rates as measured by standardised competency examinations.

Proficiency in implementing performance assessment based on social-constructivist approaches to teaching and learning is an important component of science teachers' professional development (Pilcher, 2001; Shepard, 2000a). Following the examination of the constructivist perspective on teaching and learning, Graue (1993) stresses the importance of the teacher in the development of instructional assessment:

> If we see assessment as a learning opportunity for teachers – learning about their own pedagogy as well as their students' growth – teachers must have a say in the forms and functions of assessment. Regretfully, teachers cannot do this on their own. Nothing has prepared them to make the kinds of shifts called for in either the instructional or assessment reforms … Professional development at the preservice and inservice levels is necessary to support teachers if they are to meet these challenges (p. 295).

On a similar theme, Kane, Khattri, Reeve, and Adamson (1997) view professional development as essential to reform, and teacher competency as a critical element of performance-based assessments in delivering desired student outcomes. For performance assessment to be effective, particularly assessment methodologies based on current education reform, teachers' expectations must change in relation to student outcomes and teaching styles. In this section, I will discuss the significant factors associated with advancing the case for professional development to implement performance-based assessment, encompassing professional development assessment standards, obstacles to such developments, and the features of effective training.

3.1.1 Professional classroom assessment standards for teachers

Shanker (1996) argues that "to be considered a true profession, an occupation must have a distinct body of knowledge – acknowledged by practitioner and consumer alike" (p. 220). Therefore, professional development programs to identify the knowledge and skills required for effective teaching and assessment practices are based on competencies or professional standards.

According to Mayer, Mitchell, Macdonald, Land, and Luke (2002), the competency approach came into favour in the later part of the twentieth century as a methodology for professional development programs. Debate ensued on limitations to this approach, particularly when applied to functional analysis of occupational roles such as teaching and medicine. The competency approach is based primarily on a behaviourist framework, which attempts to break down work roles into small discrete tasks, and ignores the connections between individual tasks and the meaning underlying each task. Difficulty lies in identifying a range of competencies to meet the broad functions of these professions, and then to represent the range of knowledge relevant to the identified competency. Further limitations arise from the assessment of competencies, because the process is not value free, and the people who use it shape its meaning.

The competency approach to professional development for teachers has difficulty in determining a higher level of performance and higher order skills such as those necessary for good teaching (Ingvarson & Wright, 1999). Mayer, et al.(2002) argue that attempting to define teachers' performance through competencies not only deskills teachers but also forces teachers' practices to be reproductive rather than transformative. The approach is also criticised for its potential to render teaching a technical activity with little contextual meaning (Mayer, Mitchell, Macdonald, & Bell, 2005) and it therefore cannot represent the complex nature of situations in the real world. Summing up the limitations to the competency approach, Whitty and Willmott (1991) found that many educators reject it on the grounds that (a) it encourages an over-emphasis on skills and techniques; (b) it ignores vital components of teacher education; (c) what informs performance is as important as performance itself; and (d) the whole is more than the sum of the parts.

By the middle to late 1990s there was a shift from professional competencies to performance standards (Mayer et al., 2005; Reynolds, 1999). Unlike competencies, standards include a range of factors, including values and attitudes, and they bring focus to teachers' processes, purposes, and efforts rather than relying upon professional development program outcomes alone (Mayer et al., 2002).

Loucks-Horsley, Love, Stiles, Mundry, and Hewson, (2003) state that "The vision of learning, teaching, and professional development based on standards is the why of professional development design" (p. 15). Performance standards were then developed to describe the extent of knowledge and skills required of teachers at different stages of a career – less experienced teachers, accomplished teachers, and principals (Louden, 2000). Professional standards for teaching particular subject areas, for example science and mathematics[1], and generic topics including classroom assessment, were also widely introduced.

The Americans were active at an early stage in performance standards development. The American Federation of Teachers, and the National Council on Measurement in Education and the National Education Association (1999) cooperatively developed skill standards for professional development in student assessment for teachers. The performance standards comprised the following abilities:

1. Choose and develop appropriate assessment methods for instructional decisions
2. Administer, score, and interpret the results of both externally-produced and teacher-produced assessment tools
3. Use assessment results for decision-making about individual students, planning teaching, developing valid student grading procedures, developing curriculum, and school improvement
4. Communicate assessment results to students, parents, and other stakeholders.
5. Recognise unethical, illegal, and otherwise inappropriate assessment methods and uses of assessment information (pp. 30-32).

[1] e.g., see in Australia, National Professional Standards for Highly Accomplished Teachers of Science, and in the US, National Science Education Standards

Similarly, Schafer (cited in Zhang, 1996) determined seven content areas in which teachers need to develop assessment skills:

1. Basic concepts and terminology of assessment: teachers understand and distinguish between assessment concepts: traditional or alternative assessments, formative or summative assessments.
2. Uses of assessment: teachers use assessment for different purposes; monitoring students' progress, evaluating instruction, diagnosing problem areas.
3. Assessment planning and development: when planning assessment, teachers take into account student ability, assessment targets, choose appropriate assessment methods, and use formal and informal assessment tools.
4. Interpretation of assessment: to interpret standardised test results, teachers utilise statistical concepts including variability, correlation, percentiles, standard scores, growth-scale scores, norming, and principles of combining scores for grading.
5. Evaluation and improvement of assessment: teachers use assessment tools to determine the validity and reliability of a test.
6. Feedback and grading: for grading purposes, teachers decide the grading model to be used; performance components to be included in grades; and the weighting each component receives.
7. Ethics of assessment: teachers manage usage of assessment results responsibly (pp. 5-6).

Researchers have evaluated teachers' professional standards for assessment in the science classroom. For example, Higuchi (1993) indicates that performance assessment requires teachers to have knowledge of subject matter, learning theory and human development; whilst Bhola (1990) adds provision of feedback, and the ability of teachers to assist their charges transfer of learning to life outside the classroom are important features of an effective teacher. Kane et al., (1997) suggest that teachers must be able to increase their students' ability to construct their knowledge, think critically, and move beyond one answer to a problem or project. Atkin, et al. (2001) state that:

> Professional development activities need to address: establishing goals for student learning and performance, identifying a student's understanding, and articulating plans, and pathways that help students move towards the set goals. In addition, assessment-centered, professional-development activities need to attend to providing feedback to students, science subject matter, conceptions of learning, and supporting student involvement in assessment (p. 83).

Borko et al. (1997) examine the change process experiences of a group of teachers who designed and implemented classroom-based performance assessment to meet instructional goals in mathematics and literacy. The researchers found the factors that assisted teachers to develop their instruction and performance assessment practices were:

1. the ability to set the change process in the real contexts where innovations are applied,
2. group discussion as an instrument for the social construction of innovation,
3. informal staff development to make change by introducing new ideas based on teachers' current levels of interest, understanding and skill.

An instructional innovation initiative launched in 1995, The Iowa Chautauqua Programme (ICP) provides professional development opportunities to teachers to develop the teaching and learning of science (Dass, 2001a). The program utilises constructivist principles for science teaching and learning within the context of real-life experiences. Participants in a study by Dass of implementation of the program reported unfamiliarity with both constructivism and a Science-Technology-Society (STS) approach. The researcher found that constructivism was not appropriately modelled during program activities, leading to inefficient application by teachers and indifferent outcomes. Explicit modelling of both these approaches through program activities is essential for successful program implementation. Dass recommends that teachers create a classroom environment in which students can be actively involved in making meaning of the information within a relevant, real-life context, and employ strategies which encourage active questioning and identification of issues and answers. In addition, teachers encourage students to challenge the information presented and discuss its relevance.

A three-year research project, again in USA, on professional development interventions for teachers was conducted using science curricula and teacher workshops (Hart & Lee, 2003). The substantial study examined teachers' beliefs and practices regarding teaching English language and literacy in science at elementary schools. The end of the first-year of professional development intervention showed that teachers expressed more articulate and consistent concepts of literacy in science instruction than at the beginning of the year. Additionally, effective linguistic scaffolding enhances students' understanding of science concepts. The results also suggest that teachers require continuing extensive support in the form of professional development activities to implement and maintain reform-oriented practices that promote the science and literacy achievement of culturally and linguistically diverse students.

Gearhart and Saxe (2004) designed a professional development program, based on Integrating Mathematics Assessment (IMA), to enhance elementary teachers' pedagogical knowledge in mathematics. The program was linked to particular curriculum units in upper primary grades for teaching fractions, measurements, and scales. The study's aim was to help teachers interpret the manner by which children make sense of challenging mathematical problems. The researchers found that, to implement good lesson outcomes, teachers need to investigate children's thinking and build activities, and discussions upon criteria of children's understanding. To do that, teachers need to deepen their understanding of subject matter as well as the manner by which students build their conceptual understanding. As teachers deepen their knowledge, they become more appreciative of the importance of assessment and of knowing what students know.

However, even though identifying essential skills and knowledge necessary for teachers to implement performance assessment is important, these alone are insufficient to ensure that teachers improve classroom assessment practice. To minimise the gap between expectations and realistic practices, and to determine to what extent developmental standards are applicable, implementation factors, including barriers to teacher professional development are taken into account, and these are discussed in detail in the following section of the chapter.

3.1.2 Barriers to teacher professional development

The development of teachers' abilities to use performance assessment in the classroom is affected by factors including the nature of teaching itself, teacher unfamiliarity with performance assessment, and the implementation of development programs. Issues emanating from these factors arise at all levels of program development and research, from informing education policy; to planning and executing a classroom-based assessment project (Shepard, 1997). Moreover, these factors are interactive and exhibit different influences on a given program in different situations.

In their study on a program to train teachers in performance assessment development and implementation, Morrison, Mcduffie, and Akerson (2003) state that “the instructional benefits of using performance assessment strategies seem to be established but it is not clear that teachers can easily or quickly learn to implement these strategies in practice” (p. 4). This was confirmed in the USA states of Maine and Maryland when Firestone, Mayrowetz, and Fairman (1998), observing the strategies of middle school teachers compelled to use performance assessment, found little change in instructional strategies. The researchers identified some barriers to change which are that the teachers had insufficient content knowledge to implement the performance assessment approaches to the student tests, a lack of deep understanding of subject matter, and equally, a lack understanding of the methodology so as to impart procedural knowledge to students so they could learn from problem-solving. Firestone, Mayrowetz, and Fairman (1998) reported that these obstacles emerged partly because teachers did not avail themselves of the professional development that was offered. The teachers, therefore, were unable to develop appropriate teaching practices or modify their traditional beliefs and understanding, at an appropriate level to engage students’ interest and modify their performances (Graue, 1993). The researchers examined the reasons for the teachers foregoing the opportunity to undertake professional development. The prime explanation was time. Teachers’ standard activities include interacting socially and instructionally with large numbers of students, meeting with other school staff, planning lessons, assessing student work, and participating in school activities. Taken together with extra activities due to curricula and staff changes, teachers find it difficult to gain the skills and knowledge to implement new pedagogical strategies to integrate performance assessment into classroom activities (Pilcher, 2001). A further explanation is continuous change in workplaces; as Firestone et al. (1998) observed, teachers lack motivation particularly when they "view new methods as fads imposed on them by those who do not understand" (Higuchi, 1993, p. 6).

Over time, a significant body of research (Bliem & Davinroy, 1997; Borko et al., 1997; Pilcher, 2001; Shepard, 2000b; Watt, 2005) concludes that the set beliefs teachers have constructed from previous classroom experiences facilitate or hinder teachers' ability to change their classroom assessment practices. The literature generally concludes that, without considering teachers' perspectives and beliefs, any change in their assessment and instruction methodology is expected to be both shallow and fleeting. A study by Bliem and Davinroy (1997) took into account teachers' prior beliefs about assessment, and then reported on the effects of those beliefs on teachers' abilities in implementing a new form of assessment in the subject areas of reading and mathematics. The results showed a lack of congruity between teachers' prior beliefs about assessment, and the beliefs they exhibited regarding the assessment reform methodology offered by the research team. An issue arising from the study was that teachers' ideas about assessment were unconnected from their notions of instruction and so deeply entrenched that this did not lead to a purposeful confrontation of personal beliefs. Unconsciously, teachers subverted project efforts by altering the new assessment tools so that their use fit more closely with their personal existing beliefs. Shepard (1995) reported similar findings for a group of primary teachers on a performance assessment project, noting that teachers worked from a set of beliefs consistent with traditional principles of scientific measurement.

At that time, Borko et al. (1997) also found that teachers' beliefs about instruction and assessment that were incompatible with performance assessment approaches, resulted in inappropriate implementation of performance assessment in classrooms. Teacher knowledge and beliefs about teaching and assessment need to be robustly challenged for profound change to occur. When teachers' beliefs are incompatible with the essence of performance assessment, and are not challenged, teachers are more likely to either ignore new ideas or inappropriately assimilate them into their existing practices.

Whilst the literature regarding teacher attitude to performance assessment is ageing and may be subject to revision, the entrenched beliefs model was recently supported by Graham (2005). The researcher asserts that without the process of engaging teachers' commitment to deeper regard for the theoretical grounds of performance assessment, their prior beliefs about the approach remain unchallenged to an extent that there is no significant attitude change. In an empirical study, Pilcher (2001) worked with teachers to design and implement performance assessment in their classrooms, finding that when implementing performance assessment the teachers' previous beliefs had an influential effect on their practices. The researcher noted that this was apparent when teachers used scoring rubrics, as they tended to summarise the five-point scale into a two-ordinal rating system, imitating right and wrong answers.

The literature shows that teachers' dependence on traditional assessment practices which emerge when implementing performance assessment programs, is based on psychometric perspectives (Graue, 1993; Pilcher, 2001; Shepard, 1995; Shepard, 1997). These teacher perspectives focus on item formats and methods for estimating reliability and validity, and have few connections with demand instruction (Shepard, 2000b). In addition, these attitudes present a barrier to implementing more constructivist approaches, and make only limited contributions to enriching classroom assessment practice. They also prevent teachers practising performance assessment in a social-constructivist learning environment (Graue, 1993; Pilcher, 2001).

As noted in a study by Borko et al. (1997), teachers reported that insufficient time is a hindrance to implementing new classroom methodologies, such as performance-based assessment, and in undertaking effective professional development. A particular challenge the study participants reported, was deciding upon a range of teaching and learning priorities for limited classroom time and that time was a considerable restraint to implementing performance assessment in the classroom and to planning activities and preparation of materials outside the classroom. In addition, teachers expressed time constraint concerns about scoring rubrics, recording observations, interviewing students and administering assessment tasks. Shepard (1997) found lack of time a major obstacle for teachers, particularly in the initial stages of implementing performance assessment, when time constraints adversely affected peer group discussion time for extra planning or for issues concerning scoring rubrics.

Whilst teachers undergo some induction training as part of a performance assessment program, researchers found that professional development criteria are not met. Generally, training for performance assessment is short term and generic, neglecting individual needs and the prior knowledge of teachers. Further, short-term training frequently contains inadequate information on preparation processes for teachers, and provides inappropriate opportunities for them to practice and gain familiarity with performance assessment, thus reducing the effectiveness offered through a professional development program. The *one-term* workplace sessions or workshops, which are typically considered professional development, cannot provide a real opportunity for teachers to develop their abilities (Dass, 2001b; Goodrum et al., 2001). In Australia, for instance, the Senate Inquiry into the Status of the Teaching Profession (1998) criticised professional development programs that are *ad hoc* and of a *piecemeal nature* (cited in Goodrum et al., 2001, p. 70).

In a study commissioned by the Council for Science and Technology in England, Dillon, Osborne, Fairbrother, and Kurina (2000) addressed the professional practices of science teachers in primary and secondary schools. The participating teachers reported insufficient time for training, scarce provision of accessible professional development programs related to their needs, limited opportunities to build on their initial training, inadequacy of evaluation to identify their individual strengths and a feeling of isolation created from operating independently in their classrooms. Further, professional development programs frequently omit to include teachers in writing and developing the content and processes of the programs, limiting their participation to a passive role. Shepard

(2000a) supports this view, noting that researchers design and conduct many innovative and alternative classroom assessment projects without proactive teacher input to the program. Due in part to this passive role, science teachers are placed in the position of following program instructions without understanding the principles underlying performance assessment development, nor do they attempt to change their pedagogical belief system. As science curricula and assessment reforms are often based on constructivist theory, conducting a development program on the assumption that teachers have sufficient knowledge about constructivism is not productive. Keys (2000) examined this idea within an after-school professional development session, where teachers were unsuccessfully queried on the term *constructivist.* Additionally, Dass (2001a), who undertook a professional development program for science teachers, notes: “The summer workshop was the first time that most participants had heard the words constructivism or constructivist teaching and learning” (p. 975).

A research issue for professional development for teachers that has had little attention is the profession of teaching itself. In certain circumstances, teachers work outside their area of specialisation (Grate et al., 1999; Ingvarson & Wright, 1999). In 1999, the U.S. Department of Education reported that 12 per cent of secondary school science teachers had insufficient qualifications in the subject matter they were assigned (Grate, et al., 1999). This issue has significant negative connotations for the professional development of science teachers. This problem has been caused in part because of teacher shortages in science and mathematics, and, as discussed, because knowledge of the subject matter is vital to an effective development program. In regard to teacher education, Kennedy (1998) asserts that students cannot benefit from their teachers attending professional development programs if teachers do not understand the content of such programs.

To avoid facing some obstacles that may hinder implementing professional development programs successfully, several issues should be taken into account. Firstly, sufficient information about implementing new pedagogical strategies that involve performance assessment and underline concepts should be illustrated for teachers. Secondly, teachers' motivations and beliefs may facilitate or hinder their efforts to change their assessment practices in the classroom. Also, processes of professional development should be adapted to consider individual needs and teachers' prior knowledge, taking into account the fact that some teachers are working within areas outside of their specialisation. Finally, it is important to address the nature of education system access and teachers' duties**.**

3.1.3 Designing effective professional development program for science teachers

A perusal of the literature on professional development in education shows a number of key elements of effective professional development. These visions have guided empirical studies investigating the relationship between characteristics of professional development, and changes in both teachers' classroom practice and students' learning outcomes.

Features of effective professional development programs within the literature are aligned with professional performance assessment requirements, where assessment is no longer separated from teaching practices, and the merged methodology is used to promote students' learning. As stated by the 1998 Australian Senate Inquiry, and (cited in Goodrum et al., 2001, p.70), successful professional development programs contain many of the following factors:

- teachers have significant program input
- the program is well structured, long-term and comprehensive
- the program involves a variety of collaborative partners
- the program includes evaluation, feedback, and ongoing support
- program costs are shared between government and schools
- courses relating to the program are accredited or recognised in career structures
- courses of the program meet national standards

Similarly, Loucks-Horsley et al. (2003) in designing effective professional development for science teachers, suggest the following conditions assist the implementation of a program:

- it is driven by a well-defined image of effective classroom learning and teaching
- it provides opportunities for teachers to build their content and pedagogical content knowledge and examine practice
- it is research–based and engages teachers as adult learners in the learning approaches they will use with their students
- it provides opportunities for teachers to collaborate with colleagues and other experts to improve their practice
- it supports teachers to serve in leadership roles (Loucks-Horsley et al., 2003, p. 44).

The important aspect of high-quality professional development activities, according to the American Institute for Research (Grate et al., 1999), is the degree to which they focus on teachers' mandated curriculum content. Again, this aspect was recently endorsed by Ingvarson et al. (2005), following an examination of factors affecting the impact of programs on teachers' practice. The authors developed a model of the characteristics of effective professional development programs, based on the findings from four projects of the Australian Government Quality Teacher Program. The model included contextual factors (for example, school size), structural features of programs (sufficient time), process features (content focus, active learning, follow up), a mediating variable (level of professional community generated), and four outcome measures (knowledge; practice; student learning, and efficacy). Effective factors were content focus, active learning, follow-up on knowledge, and professional community. Sheffield, Hackling, and Goodrum (2005) examined data from the larger Collaborative Australian Secondary Science Program study, applying a professional learning model for teachers of secondary school science. The model included elements of curriculum resources, professional development workshops, and reflection. The study identified a number of primary and secondary factors that affected the success of the program. The primary factors include professional development workshops, curriculum resources, and participative inquiry; the secondary factors are collaborative and peer support, support from students, time to work through the concerns and develop new pedagogical content knowledge and leadership, and support from the school executive.

To determine the effective factors for professional development, a literature review by the American Institute for Research (Grate et al., 1999) evaluated the extent to which the Eisenhower Professional Development Program supported high-quality professional development of teachers. Identified factors were divided into *structural features* and *core features*. The structural features included: reform type, duration of the activity, and collective participation. Core features included content focus, active learning, and coherence in teachers' professional development. The results indicate that activities with more positive structural features provide professional development experiences, which result in more positive teacher outcomes. Activities of a longer time frame tend to place more emphasis on content than shorter activities, offer more opportunities for active learning and provide consistent professional development. Also, activities with cooperative participation offer opportunities for active learning and provide coherent professional development. Kennedy (1998) asserts that the process content (classroom management, discipline techniques, knowledge of subject matter and students' learning processes) of a development program is its most important feature. In a review of mathematics and science classroom programs, the researcher found that programs instructing teachers to model scientific reasoning have a greater influence on student achievement than programs regarding use of the learning cycle.

To be effective, professional development should consider teachers' participation in designing and conducting professional assessment programs, and in developing standards for professional assessment practices. For instance, in USA and Australia, teachers participate in the matter of setting professional teaching standards. This involvement could extend to professional programs, with teacher outcomes of greater motivation, and greater program responsibility. In addition, teachers require in-depth training for instructional strategies such as collaborative learning, problem-solving, open-ended tasks, student self-assessment, and ungraded primary instruction (Higuchi, 1993). An English study found that science teachers need continuous professional development and the opportunity to share with peers their experiences, good practice, and compare practices (Dillon et al., 2000). The teachers preferred higher quality training with more emphasis on classroom-focused support and individual needs. They were concerned about the wide range of training activities, difficulty accessing assistance, limited opportunities for practising teaching styles, assessment methods and new materials in their classes, and sufficient time to reflect on these experiences.

After working with teachers in a classroom performance assessment project, Shepard (1997) found that to make changes that are theoretically meaningful, teachers require support on an ongoing basis, appropriate materials to sample and adapt, time to reflect, time to develop new instructional approaches, and support from experts to learn (and challenge) the conceptual basis behind intended reforms.

Based on the literature, an effective professional development program is characterised by: 1) teachers have significant input into the program; they may develop standards for professional assessment practices; 2) it is well-structured and driven by well-illustration of effective classroom learning and teaching; 3) it involves many activities that provide opportunities for teachers to collaborate with colleagues and others ; 4) it takes a long period providing ongoing support including evaluation and feedback , and 5) it focuses on the content that teachers must teach, giving them opportunities to build their pedagogical content knowledge and examine practice.

3.2 Research examining the effects of performance-based assessment on science teachers and students

Over time, critics of traditional student assessment practices, as discussed in Chapter 2, called for fundamental change in assessment. Research has consistently supported performance-based assessment as an alternative to traditional assessment procedures. As noted (Chapter 2), performance assessment is integrated with the teaching process and based on constructivist learning approaches. Advocates of this form of assessment report positive changes in teaching and learning outcomes, and that these constituent dimensions attract considerable research and policy-making activity.

3.2.1 Research examining the effects of the use of performance assessment on teachers

Through research, science teachers involved in implementing performance assessment methodologies demonstrate substantial development in their teaching and assessment practices. In a study to implement performance assessment in science programs, O'Sullivan, McColskey, and Harman (1992) found that science teachers trained in the use of performance assessment generally reacted positively to using the methodology, the process however was slow change and teachers faced difficulty in breaking away from traditional assessment practices. Shepard et al (1996) also support this finding following a year-long performance assessment of students and teachers, where participating teachers showed fundamental and conceptual changes in their teaching style. Once again these changes in instructional strategies occurred slowly. The changes included increased instructional strategies focused on meaning, greater use of manipulation, and a wider range of materials used to teach problem-solving strategies.

In another study, Shepard (1997) involved a team of researchers to work with teachers to assist them to develop or select performance assessment tasks for their personal instructional goals. The study revealed that most of the teachers were using mathematical activities closely aligned with USA's National Council of Teachers of Mathematics to replace and supplement more traditional practices of text-based work, and they extended the range of mathematical challenges considered feasible for third graders through a greater knowledge of students' abilities. Teachers developed greater sophistication on scoring criteria, and revisited assessment issues that were earlier problematic, and they increased comprehension of the multiple dimensions within scoring rubrics.

Conducting a professional development project on design and implement of classroom-based performance assessment for a group of third grade teachers, Borko et al. (1997) found teachers changed their instructional and assessment practices. Identified change processes included the use of more problem solving activities; developing and implementing rubrics for scoring open-ended problems and emphasising student explanations. Also, teachers expressed substantive change in their approaches to students' understanding, but there was less change in the teachers' use of record-keeping systems as they observed students working on activities.

Wozny (1998) worked collaboratively with a group of science teachers to design, implement, and analyse performance assessment activities. The researcher found that, after designing and implementing the sets of performance assessment, the participating science teachers showed enjoyment and approval of the performance assessment process. The teachers had reservations, however, about the time involved in the preparation, and implementation of performance assessment activities, particularly with large classes.

A performance assessment program developed for an elementary science methods course focused on teaching science through inquiry strategies (Guy & Wilcox, 2000). The teachers, after substantial preparation, administered the performance assessment program in an elementary school, and were measured on the following factors: scoring a rubric, advocating inquiry, assessing inquiry, and implementing the teaching standards described in the rubric. The results indicated that teachers considered the assessment task educative, and believed that the performance assessment experience increased confidence in hands-on teaching, as well as being useful in assessing personal teaching strengths and weaknesses.

To assess the impact of using performance assessment techniques, (high-stakes and mandated) in instructional practices, Vogler (2000) surveyed teachers of tenth grade English, mathematics and science. The study results showed that teachers were making changes in their instructional practices through increasing the use of open-response questions, creative/critical thinking questions, problem-solving activities, use of rubrics or scoring guides, inquiry/investigating, and cooperative learning/group work. Vogler found a decline in the use of lecturing, true-false questions and multiple-choice questions. Consistent with other findings in this discussion, the results included an observation that teachers with 28 years or more experience reported the least amount of change in their instructional practices, whereas the teachers with 13-19 years' experience reported the highest change component.

Mcduffle, Akerson, and Morrison (2003) conducted a study of preservice, that is, trainee teachers to assess the effect of designing and implementing science performance assessment tasks, based on the study group's understanding of standards-based assessment. The teachers were trained for a semester in designing and implementing performance assessment tasks. The results indicated that the teachers understood assessment as a formative process, and constructed valid concepts of performance assessment. The study findings included an inability for the teachers to adequately analyse student thinking, thus, design adequate inquiry-based science instruction, primarily because they lacked experience with rubrics. In general, the results conformed to the findings of other researchers by demonstrating that professional development in performance assessment is worthwhile but difficult to implement.

In a similar study to others in this review, Gearhart and Saxe (2004) conducted a professional development program for elementary school teachers on a formative assessment basis. The researchers trained teachers in the new methods of teaching and assessment, using performance assessment tools such as open-ended tasks, brief queries during small group activities, portfolio assessment, and open-ended questions during class discussions. The authors reported that building teachers' knowledge of subject matter and methods of assessing student thinking can strengthen classroom practices, and increase student understanding and skills.

The process of change was the focus of Graham's (2005) investigation using a mentored learning environment to examine variations in teaching theories and practices. Over time, the researcher gathered data on teachers' growth in knowledge about classroom-based assessment and assessment-driven planning. The study shows that teachers were strongly influenced by professional dialogue about planning and assessment. However, while most teachers accepted that classroom-based assessments provide evidence of student learning, issues raised included dimensions of designing goals, rubrics, grading and fairness, grading and motivation, validity of assessments; and time constraints for performance assessment implementation.

3.2.2 Results of research about performance-based assessment in learning and attitudes toward science

In an early study of alternative assessment in science, Shavelson, Baxter, and Pine (1991) developed performance assessment tasks aligned with science reform for primary school classes. Analysis of the data indicated that performance assessments can be developed through an extensive, and iterative, development process. The researchers distinguished students who experienced hands-on science from students who received a traditional text-book approach, and concluded that performance assessments measured different aspects of science achievement which were not measured by traditional assessment.

Following this approach to study the cognitive domain that could not be measured by traditional assessment methods, Baxter and Glaser (1996) sought to identify the role of performance assessment in cognitive activity of teachers and students. They observed elementary school students whilst the researchers implemented a science performance assessment that required the students to verbally communicate their thinking processes as they worked. The descriptions of the cognitive activities of the students highlighted significant dissimilarities between those who think and reason well with their knowledge of the task, and those who do not. The researchers hypothesise that awareness of, and attention to these types of activities can support the development of thinking and reasoning in the elementary science classroom. Baxter and Glaser conclude that performance-based assessment not only supports reasoning development, but also provides teachers with feedback that can be used to improve the classroom environment.

In a study linking science instruction and assessment in a classroom, Enger (1997) examined student performance on a set of open-ended science tasks including graphing data, interpreting data, writing conclusions, identifying control variables and judging the validity of information. The study investigated the link between instruction and assessment using science inquiry learning opportunities fostered within middle school science. The results show that performance assessment provides diagnostic information on students' performance, and adds insight into the strengths inherent in students' answers, and the weaknesses perceived as useful for diagnosis. Students reported science learning opportunities that can be used to practise science as inquiry.

Biondi (2001), examining authentic assessment strategies, found encouraging results in an action research project for an elementary classroom. The project used a model of teaching focused on the inquiry method of teaching science and performance assessment methods that encourage students to be active in learning and assessment processes. Biondi found that performance-based assessment is a valid, equitable measurement of student progress. The students were focused, able to reflect on their learning activities and abilities, and developed a higher level of vocabulary through group conferences, and self-assessments. Performance-based assessment provides students with tangible evidence of their work, as they analyse their strengths and weaknesses, focused on their work, and apply their knowledge of the material in a creative manner.

Similarly, Parker and Gerber (2002) studied the effectiveness of performance-based assessment for evaluating elementary students' science achievement in exhibiting presentations at a science festival. Implementing performance assessment required them to align curriculum content, instruction, and assessment. They found that performance-based assessment was an effective measurement methodology.

To study the effects of performance assessment on both the low and high achievers in primary school, Gray and Sharp (2001b) compared two assessment modes, performance assessment and pencil and paper tasks. These modes of assessment are included in the Assessment of Achievement Program (Science). The results of the study show a consistent difference in favour of performance assessment, although the differences between the low and high achievers' responses were inconclusive. Differences between the two modes however, were more prominent with the low achievers.

A similar result was found by Chang and Chiu (2005) when they developed forms of authentic assessment to investigate students' scientific literacy to meet the requirements of curriculum reform in Taiwan. The result of the large, two-year study of authentic assessment was compared with the Science section of Taiwan's Academic Attainment Testing (STAAT). The researchers found that authentic assessment was superior in evaluating students' authentic ability in science than the standardised tests of STAAT. In addition, authentic assessment, primarily the hands-on assessment activity, benefited low achievers.

As discussed, several studies confirm performance-based assessment's results in improving student learning outcomes; however, studies were conducted that report no positive effects for performance assessment for science students. Shymansky et al. (1997) with a team of science educators, designed five performance tasks, four of them conducted on ninth-grade students at four schools. Each student took two or three of the five performance tasks, following completion of the Iowa Test of Educational Development (ITED) and mirroring the nature of the ITED test. The researchers found that students performed poorly on all performance tasks compared with their recent results on the ITED. Arguments for this outcome proposed by the researchers were teacher and student inexperience in working within a performance assessment context, and technical problems in scoring guides. According to study procedures, the inexperience reason is more likely to have had an impact on achieving this result. Performance assessments were presented to students immediately after the main traditional assessment tests, so they were more familiar with traditional test strategies that focus on one right answer and that measure particular factual knowledge. On the other hand students did not receive sufficient training to use critical thinking skills through strategies compounding assessment and learning processes, such as those found in Biondi's (2001) study.

A similar result was found by Huff (1998), who conducted a small study of assessment of science learning in lower primary students, using multiple-choice item formats, and performance formats. The results show several disadvantages to performance tests, related to time and efficiency of testing. These outcomes may be related to unfamiliarity with performance formats for the students. Another possibility is that performance assessments have essential factors, as discussed in Chapter 2, which require drastic changes in teaching styles, curriculum materials, classroom environment, and learning methods. Research by Century (2002) compared the impact of alternative and traditional assessment methodologies. Two groups of primary students were taught the same lessons by the same teaching methods, but assessed differently by performance-based assessment and traditional test forms. The results were that, while traditional tests promoted concrete cognitive knowledge, alternative assessment yielded more psychomotor, cooperative learning and critical thinking skills. There were no significant differences between groups in terms of students' attitude toward science. However, qualitative analysis showed that the alternative assessment group was more satisfied with their experiences, thus supporting research outcomes of Herman, Klein and Wakai, (1997). These researchers collected substantial data to investigate whether students find alternative assessment methodologies more motivating and interesting than traditional test forms. The results indicate that students find the alternative assessment modes more interesting and challenging. Similarly, the result reported by Biondi (2001), shows most students were in favour of performance assessment.

By reviewing these previous studies, some observations can be made. Firstly, studies that integrated performance assessment with teaching processes and involved students in assessment processes have changed substantially to improve students learning. Secondly, most studies that separated assessment from teaching and used performance assessment to assess learning, instead of using it for learning, failed to make desirable changes in students' learning. Thirdly, as performance assessment requires thinking skills and promotes habits of mind, students need a sufficient period of time to practice reasoning skills beyond what they used to practice with traditional assessment. Most studies showed that performance assessment has positive effects on learning and teaching with long-term teaching, therefore effects were expected to be limited for both students and teachers over such a short study experience.

Also, to use performance-based assessment effectively, it must be integrated with curriculum and instruction (Kane et al., 1998). Learning environments where performance based assessment is introduced without the full support of those who will manage instruction and evaluation may not demonstrate the necessary levels of commitment of the implementation of this approach. However, incorporating performance-based assessment within teaching and learning is considered the biggest obstacle to improving student learning (Sweeny, 1996). Therefore, it was no surprise when the results of some studies showed low effects from using it in the classroom.

3.2.3 Summary

Professional development for teachers to adequately implement performance assessment in the science classroom can be grounded basically on standards that have been highlighted in the professional literature (American Federation of Teachers (AFT) et al., 1999; Borko et al., 1997). However, these standards represent ideal theoretical practices that can not be achieved by teachers unless practical factors that influence teaching practices are taken into account, whether they are related to teachers (e.g., prior knowledge, beliefs about previous practice), to school environment (e.g., class size, teacher duties within the school) or to the nature of the educational system in general. Several studies (Grate et al., 1999; Ingvarson et al., 2005; Loucks-Horsley et al., 2003) indicate that in an effective professional development program, teachers make a significant input and should participate in developing standards for professional assessment practices. Professional development involves variety of activities that provide opportunities for teachers to collaborate with colleagues and other professional over extended period with provision of ongoing support that includes evaluation and feedback.

CHAPTER 4: SAUDI EDUCATION SYSTEM

This chapter presents an overview of the educational system in Saudi Arabia. It includes a profile of the country, the main characteristics of its educational system, development options for the system, and benefits and constraints pertaining to those options. Three key elements considered are curriculum, assessment, and teaching, with an emphasis, where relevant, on primary school science classes.

4.1 An overview of education in Saudi Arabia

4.1.1 Profile of Saudi Arabia

Saudi Arabia was founded in 1932 by King Abdalaziz Al Saud, when the state was united under one government. The official name of the country, which came from the Royal family name, is the Kingdom of Saudi Arabia (Al-Baadi, 1995). Saudi Arabia is the largest country of the Middle East and occupies about 2.25 million square kilometres of the Arabian Peninsula from the Arabian Gulf in the east to the Red Sea in the west. ‘Geologically, the land area resembles a great tilted slab of ancient rock, its surface pushed into a high mountain range in the west and with a vast plateau of sand and rock, cut by occasional wades and escarpments, stretching down to sea level on the Gulf’ (Cameron, Cowan, Hurst, & McLean, 1984, p. 750). Saudi Arabia is bordered by Kuwait, Iraq, and Jordan to the north, Yemen to the south, Oman to the south-east, and by the United Arab Emirates and Qatar to the north-east (Siddiqui, 1996). The country is divided into 13 regions, or administrative divisions, including over 6,000 cities, towns and villages (Al-Sadan, 2000). The population, according to the latest census conducted in 2004, is 22,673,538, of which 16,529,302 (72.9%) are Saudi and 6,144,236 (27.1%) are non-Saudi (Ministry of Economy and Planning, 2005).

For centuries, the Saudi environment and society were influenced by two factors, desert life and the Islamic Sharia (the religious and moral laws of Islam) (Al-Sadan, 2000). Before the discovery of oil, Saudi Arabia was a subsistence economy, relying on subsistence farming, petty trading, pearl fishing, and pilgrimage dues. In 1938 oil was discovered in the eastern province, and this resource was developed immediately after World War II by the Arabian American Oil Company (ARAMCO), thereby launching the kingdom as a major oil producer (Cameron et al., 1984). The vast revenues from oil exports were invested in the country’s development to create a social infrastructure including healthcare and education, a public administration structure, and a private sector economy consisting of agricultural and industrial sectors (Bahgat, 1999).

4.1.2 Development of Saudi education

Until the last few decades, the Arabian Peninsula’s perennial instability caused widespread illiteracy. As in the Western region (the Hijaz), education commonly consisted of the kuttab, where a group of boys or girls learned basic writing and arithmetical skills to memorise the Quran and other religious texts (Almegidi, 2004; Ministry of Education, 2001). Rote memorisation of basic texts continues to be a central feature of the Saudi educational system (Rugh, 2002). During the Ottoman rule to the early twentieth century in the Hijaz and Eastern region (the Ahsa), in addition to religion, Turkish-oriented schools taught geography, history, and art, but most citizens avoided enrolling their children in these schools to protect them from conscription by the Ottoman army. However, to meet educational needs beyond the kuttab schools, Saudi parents established a private school system offering a wider range of subjects in Arabic (Rugh, 2002).

A Directorate of Education was established in 1924 to implement a comprehensive educational system in Saudi Arabia (Al-Sadan, 2000). The structure created by the Directorate initially offered males six years of elementary and five years of secondary education, later changed to six years of primary school, three years of intermediate school, and three years of secondary school. As the Directorate was responsible for all schools and Islamic colleges in the Kingdom, it also assumed control of private schools, issuing regulations confirming government control over all educational matters, excluding the military academies, in 1938 (Rugh, 2002). Considerable resources were expended to instil a sense of educational zeal throughout the population, although progress was slow during the period (Ministry of Education, 2001).

By 1945, King Abdulaziz Al-Saud, the country's founder, initiated an extensive program to establish schools in the Kingdom. Six years later, in 1951, the country had 226 schools with about 30,000 students. In 1953, the Ministry of Education replaced the Directorate of Education, specifically to expand the existing school system for male students to meet international standards, although the core of the system was, and still is, religious studies (Al-Sadan, 2000). The Ministry provides boys (and now girls) with elementary, intermediate, and secondary education facilities, and has a number of specialised institutes (Al-Baadi, 1995).

The General Administration of Girls' Education (GAGE) was established in 1960, independent of the Ministry of Education and under the administration of *ulama* (religious authorities), although provision of girls' schools was delayed due to concerns of the effects of modern educational principles on girls (Al-Baadi, 1995). By 2002 administration for the GAGE was transferred to the Ministry of Education, a move which faced initial opposition from *ulama* in some regions.

Resources for the Saudi educational system were allocated as part of a series of five-year development plans for the country. In the Ministry's first development plan, the initial objectives were:

- to provide at least basic education for all citizens
- to provide students with the skills that are required by the changing needs of the economy
- to educate students in the beliefs, practices, and values of the Islamic culture (Al-Baadi, 1995).

The latest ten year plan (2004-2014) builds upon past achievements to maintain Saudi Arabia's position in the international community:

- all children from 6 years to 18 years are to attend public education
- all students are to be exposed to positive cultural and educational experiences, both national and international, to achieve standing in mathematics and the sciences
- emphasis to be placed on improving the quality of the educational system
- school curricula to be developed according to Islamic values, to build character in students, and provide them with knowledge and logic skills
- improve the quality of all teachers

- continue to develop and modernise the educational environment, especially schools' plans
- upgrade information and communications technology, using it in the acquisition of knowledge and skills
- expand social participation in education (Ministry of Education, 2004, pp. 20-21).

The Saudi government promotes skills and knowledge acquisition as *Education for all*, providing free education from primary school through to university. Students are provided with a monthly allowance, uniforms, books, transport, and other necessities as required (Bahgat, 1999; Rugh, 2002). Resources allocated to education since the establishment of the Ministry in 1953 grew rapidly. In the financial year 1954-55, $AU21.1 million was budgeted for education and by 1966-67 this was $AU92 million. Government spending on education in 2000-2001, as shown in Table 4-1, reached $AU15,771 million, climbing to $AU17,230 million by 2003-2004 and representing a large part (21.08%) of the national budget (Ministry of Education, 2005b).

Table 4-1 The Growth in the General Budget of Saudi Arabia and the Budget of the Ministry of Education, Financial Years 2000- 2004

Fiscal Year	General State Budget $AU m	Male Education Budget $AU m	Female Education Budget $AU m	Education as a proportion of State Budget
2000-2001	66,071	7,232	8,539	23.87%
2001-2002	76,785	7,561	7,748	19.94%
2002-2003	72,143	7,759	8,975	23.19%
2003-2004	74,642	8,025	9,205	21.08%

(Ministry of Education, 2005b)

As a result of this large allocation of funds over the years, Saudi education grew rapidly. In 1952-53 there were 39,920 male students in primary school, increasing to 267,529 in 1969-70. By 2003, however, the number of students reached almost 1,220,000, as shown in Table 4-2.

Table 4-2 Growth of Primary School Enrolments and Schools (boys)

School Year	Schools	Students	Teachers
1952-53	306	39,920	1,472
1962-63	903	139,328	7,568
1969-70	1,383	267,529	12,157
1979-80	3,638	517,069	28,156
1990-91	4,806	919,949	55,381
2002-03	6,386	1,219,569	96,375

(Ministry of Education, 2005b)

A measure of this investment in education is the rise in literacy over the period 2000-2004, as shown in Figure 4-1, to 98.1 per cent for young males, and 93.7 per cent for young females.

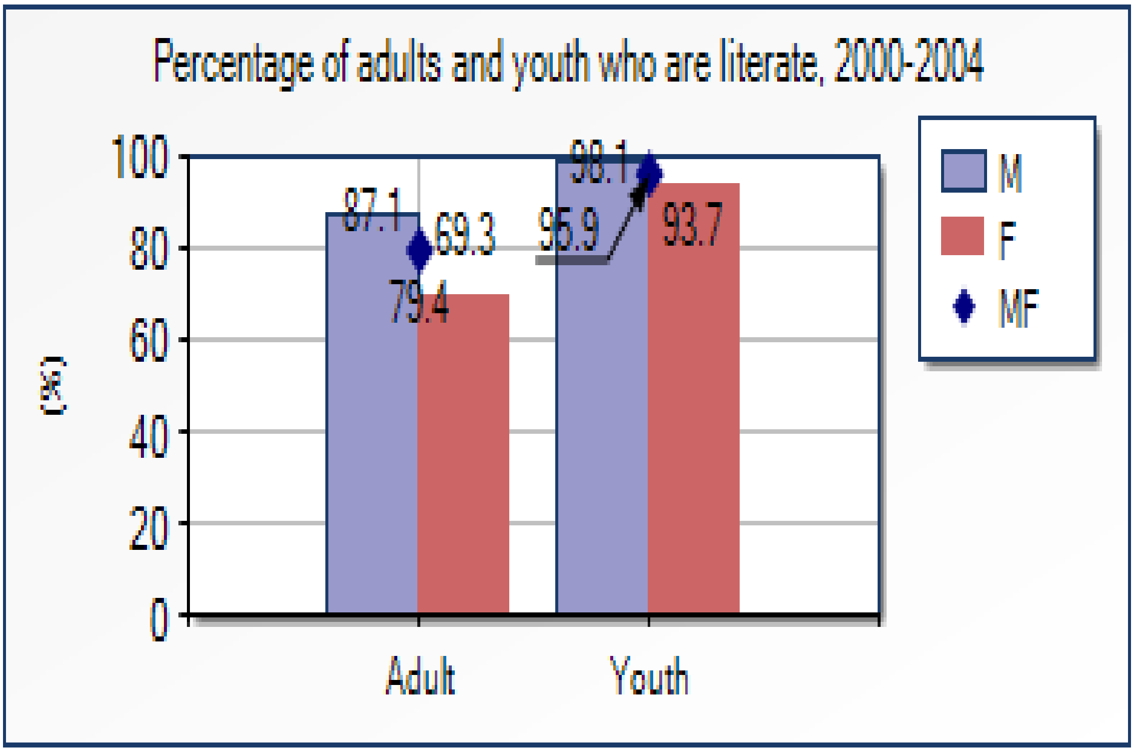

Figure 4-1 Literacy Rates for Youth. (UNESCO, 2004)

The adult education rate also climbed, to 87 per cent, as shown in Figure 4-2. Saudi Arabia has a high rate of literacy compared to other Arabic countries, such as Egypt and Algeria, both of which launched their education systems prior to Saudi Arabia.

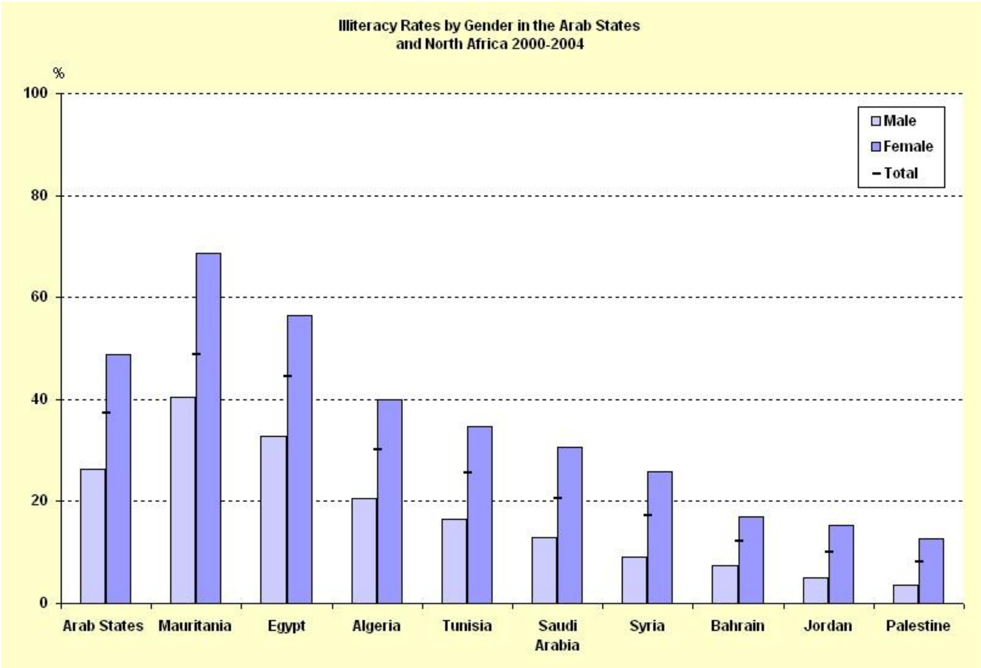

Figure 4-2 Illiteracy Rates by Gender in the Arab States and North Africa, 2000 – 2004. (UNESCO, 2004)

Moreover, due to social and economic demands, the school curricula have widened to involve social science, mathematics, science and civic education. In 2002, concerned for the nation's fluency in English, the lingua franca for engineering, medicine, and the natural sciences, the Ministry of Education brought back the study of the language in primary schools to 9 years of age from 12 years (Ministry of Education, 2005b; Rugh, 2002).

Whilst subject to direction from the Ministry of Education, private schools nevertheless increased their presence within the overall Saudi school system, providing primary school instruction from kindergarten through to level 12 with a Ministry-approved curriculum. The growth in private schools reflects several demographic and socioeconomic factors of the country. First, the high growth rate of the population, currently about 3 per cent, increased pressure on government schools and the government encourages the private sector to invest in education by offering financial support (Measurement and Assessment Department, 2003). Second, the increase in the number of working Saudi mothers has led to greater use of both Ministry-provided and private day-care centres and kindergartens (Al-Baadi, 1995). Third, private schools offer a quality standard of education which attracts those of higher income means. The attractions of private schools include smaller class sizes, more accessible hours, specialty subjects including computers and early years English, and a greater range of activities than publicly-provided schools (Al-Baadi, 1995; Rugh, 2002).

4.1.3 Options and constraints in developing the Saudi educational system

The educational system in Saudi Arabia shows a successful implementation in recent decades, moving beyond a rapid quantitative strategy to provide a universal basic education, to its current qualitative focus to improve standards of educational delivery and the quality of outcomes for the graduates. The Ministry is exploring separate strategies to identify optimum paths to provide adequate skilled human resources to continue the country’s economic and social development.

At the time of this study, several key programs were being used to pilot different approaches in different educational areas. Examples of these projects follow, as an indication of the directions the Ministry is pursuing.

Saudi Leading Schools project

This project derived from the education system in Victoria, Australia. It was instituted in Saudi Arabia in 2002 as a means to address deficiencies in public schools' responses to individual students' needs. This model is interactive, technical and incorporates a variety of resources. It accords the school a degree of self-administration, and provides a flexible curriculum based on openness and partnership with the local community (Ministry of Education, 2002). After six years of implementation in five primary and intermediate schools, the project is still under review (Al-Hamed, 2005).

School evaluation program

This program is a continuing and comprehensive evaluation method for all aspects of a school, including environment, administration, teachers, and students. It relies upon specific measurement tools and uses quantitative targets (Ministry of Education, 2004). The project is based on educational measurement and quality standards used by the British Office for Standards in Education, the entity responsible for evaluating public schools in the United Kingdom (Al-Hamed, 2005).

School personnel evaluation project

A project to identify professional standards for teachers, supervisors and school principals by using objective measurements began with a pilot for a teacher competency test in 2001 (Ministry of Education, 2004). The test is now one of a suite used for teacher selection, whilst supervisor and principal competency criteria were being evaluated at that time.

Thinking skill development program

In 2002 a program was implemented to assist students to move from rote learning habits to develop problem-solving skills and to seek creative solutions. This entails restructuring the primary school curriculum to introduce interactive class activities, and therefore implement improvements to cognitive skills for educational practitioners (Ministry of Education, 2004). The first phase of the project included a training program for educational leaders and issuing a teacher's guide for the development of thinking skills (Ministry of Education, 2004).

In addition to these initiatives in 2003, Saudi participated for the first time in TIMMS (Trends in International Mathematics and Science Study), which provides a benchmark of reliable and timely data on the mathematics and science achievement of students compared to those in other countries.

However, there is a challenging environment for Saudi education, both from the educational reform movement and from the system itself. As the Ministry of Education Report (2000-2004) indicates, a prime consideration is the increasing number of students entering the educational system in high population growth countries such as Saudi Arabia. Since the 1930s, the Saudi population has a population growth of more than four times (Almaraee, 2003), with annual growth now estimated at 3.3 per cent, according to WHO (2005). Another challenge is that of preparing graduates for the future economic and social needs of the country and its world position, which requires greater emphasis on mathematics, science, and technology; as well as the adjustments educational reform demands (Ministry of Education, 2004).

Many researchers (Al-Sadan, 2000; Bahgat, 1999; Rugh, 2002; Samman, 2003) argue that reforming the Saudi educational system is not simple. Although it is a public system, regulated centrally by the Ministry of Education, there is little indication of educational reform initiatives; thus the country's 42 dependent educational districts are not authorised to introduce the systemic change required to meet the growing demands of their communities, and the country's employers. The centralised Ministry is suffering from a severe shortage of qualified educators as future leaders of reform, due to the attraction of the private sector. The private sector appeal stems from the absence of public sector incentives, appropriate compensation and continued training, for its skilled professionals, and perhaps because the government institutions are uninterested in developing quality educators as leaders (Al-Ghamdi, 2005).

4.2 Primary education issues

The issues presented in this section have contributed to difficulties throughout Saudi public education, but as this study focuses on primary education, those matters relating to this division of the education system will be discussed. There is agreement among Saudi educators (Al-Ghamdi, 2005; Al-Otaibi, 2005; Al Yahya, 2004; Almegidi, 2004) that the primary education structure and the policies that underpin it cause many difficulties, foremost among which are: educational waste, inadequate evaluation and testing, the low standards of proficiency for teachers, and inappropriate school buildings.

The issue of educational waste refers to the imbalance of educational function where input resources are not reflected in the quality of output. Several studies report that resource application fails to prevent a high level of student's grade repetition and student dropout rates. The first study conducted by the Ministry of Education from 1972 to 1981, shows that the rate of repetition of grades for primary students (boys) to reach the required standard of the next grade ranged from 18 per cent (1972) to 24 per cent (1981) for grades one to five, and from 8 per cent (1972) to 15 per cent (1981) for grade six (Servastva, 1984). The study also indicated that the rate of dropout ranges of 6 per cent to 7 per cent at grade one, 4 per cent to 5 per cent for grade five and 2 per cent to 4 per cent for other grades. In a 1997 longitudinal study the Ministry conducted on 1000 students, it found that 384 students graduated from primary school after six years, whereas 297 graduated after seven years, and 180 graduated after eight years (Abdaljoad, 2004).

Al-Otaibi (2005), and Al-Yahya (2004) assert that an assessment system that relies on traditional tests to allow a student to move to another grade is responsible for many of primary education's issues. The authors found that the majority of the students who drop out of Saudi primary schools have failed in one or more subjects, and repeated their grade more than once. Particularly in grade levels, assessment practices based on traditional testing methods are related to increased rates of anxiety and stress in students (Al-Otaibi, 2005). Moreover, those students who receive low scores on traditional tests develop inferiority patterns that negatively affect the growth of their personalities and may force many of them to leave school.

Although educators agree that educational assessment policy needs radical change, many believe that the acute problem facing primary education in Saudi Arabia is the lack of teacher proficiency. Whilst teacher proficiency has many dimensions, it may occur as a deficiency in the traditional teaching role that focuses on preparation of the subject, student indoctrination, and ensuring students' recall in exams, which is a major source of intimidation for students (Al-Yahya, 2004). For a considerable time, a further dimension of proficiency, the standard of teachers' qualifications, adversely impacted on the country's primary education (Abdaljoad, 2005). Primary teachers initially did not require tertiary qualifications, that is, a bachelor's degree, and this is best illustrated by records in 1988 which show that 50,643 Saudi primary school teachers, nearly 80 per cent of the total number, lacked this qualification (Al-Dayel, 1989).

Productivity of an educational system per se is influenced by resources, including physical infrastructure. Saudi Arabia's population growth determines the number and location of school buildings, and an inadequate supply of purpose-built buildings resulted in the use of generic portable buildings and rental accommodation, The unsatisfactory outcome from this lack of planning is that, at the time of writing, 55.3 per cent of buildings designated as primary schools are actually rented houses (Ministry of Education, 2006). Buildings adapted for use against their purpose are inherently unproductive and especially unsuited for the dynamics of the classroom and children's activities. Further, the designated buildings lack necessities such as appropriate ablution facilities, safety and security measures. Specialised functions, such as libraries, meeting rooms, and laboratories are not provided (Al-Otaibi, 2005; Almegidi, 2004). Compared to purpose-built schools, this adaptation of building for primary school purposes significantly restricts the student occupant, who has on average 80 per cent less space than a student allocated to a purpose-built standard primary school (Al-Yahya, 2004). Al-

Yahya (2004) continues that rented schools negatively affect the educational process, restricting a teacher's style of imparting knowledge, and also limits the types of targeted and extra-curriculum activities, and the use of technology in education. In addition, it reduces opportunities for sports and social activities, again negatively impacting on the personal development of students at this critical group stage (Almegidi, 2004).

Although the population growth rate impacts on the Ministry of Education's ability to provide a standard education for all children as its charter stipulates, many educators (Al-Otaibi, 2005; Almegidi, 2004) query the Ministry's lack of strategic planning in relatively simple matters such as the predictable demand for purpose-built accommodation and adequate resources to meet the country's future educational needs. The perennial issue of adequate physical infrastructure was addressed by the Council of Ministers in 1999, who directed the Ministry of Education to contract the private sector for school buildings of appropriate standard. The Ministry then leases these buildings for a given period, at the end of which they become the property of the Ministry (Al-Yahya, 2004).

4.3 Development of Saudi education framework

This section focuses on the development of the dimensions of the primary education systems that relate to this study: science curriculum, assessment, and teaching.

4.3.1 Primary science curriculum development

Initially, Saudi educationalists adapted the curricula of other Arab countries, Egypt especially, to the country's own purposes, such as an additional emphasis on religious subjects (Al-Baadi, 1995). To initiate the important technical curricula in the early 1970s, however, the Ministry of Education contracted the Educational Centre for Mathematics and Science at the American University in Beirut, Lebanon to develop mathematics and science curricula for use in Saudi schools (Aldamegh, 1998). In collaboration with educators from Saudi universities, the extensive preparation for this project involved analysis of standards of students' existing academic achievements, and the subject perception standards for intermediate and secondary school students. The project team then set about determining subject standards for each course and their appropriate content units; preparing teachers' textbook guides and setting methodology for the continuing evaluation of their work. Lastly, awareness and preparatory workshops were held to transfer the knowledge required and to build skill levels for the stakeholders from the schools (Aldamegh, 1998). Of these original structures, the science curriculum, with minor modifications to the textbooks, was used for the next 20 years (Al-Abdulkareem, 2004). In 1999, to meet the growing criticism of the curriculum content, a team of nine educational supervisors was assigned to develop temporary primary school science textbooks whilst undertaking extensive research to meet best practice standards in curricula. Al-Abdulkareem (2004), as a member of the team, described the work strategy as follows:

- researching available curricula from best practice countries, and adapting it for Saudi use
- using new teaching methods: problem-solving, class discussions, individual discovery, and small research projects: to encourage take-up of this teaching style, answers for most activities were omitted
- focusing on problem-solving material; and optional, interesting independent activities, especially for exceptional students
- minimising compulsory material, adding new optional sections
- replacing scientific experiments requiring resources not readily available with experiments for which materials were at hand
- updating information and replacing dated factual text with the latest technological and scientific material
- using new designs and illustrations, taking into account updated educational and technical aspects
- the textbook subjects required rewriting in the vernacular.

At that time, the Ministry of Education established the General Project for Curriculum Development, a well-resourced program to redevelop curricula to meet educational policy objectives. Drawing on research findings, both local and international, the overarching aim of the General Project is to identify and implement best practice curricula, The curricula will interact with new educational technologies, benefit from others’ experiences, specify skills to be acquired by students at every educational level, link information with everyday life, develop critical thinking and performance skills, and developing skills for productive work (Ministry of Education, 2005a). The three-year project included coordination across all stakeholders in Saudi Arabia, field studies and research, ratings of the current curricula, plus training courses, specialised workshops, visits between curricula committees in the Gulf region and elsewhere, and reviews of other countries' experiences (Ministry of Education, 2005a).

4.3.1.1 Evaluating primary science curriculum

As all school curricula have common factors, a science curriculum may be evaluated using those factors in comparison with other subjects. First, all subjects for boys and girls are produced by the Ministry of Education, using curricula departments in the Ministry and external expertise to develop elements such as goal setting, developing the syllabus, and creating the textbooks. It should be noted that teachers, parents and local community are rarely involved in these processes. Second, all textbooks for primary, intermediate, and secondary schools are published by the Ministry, and issued free to all students in public and private schools. Accordingly, students in each grade have identical textbooks. Whilst laudable for standardisation purposes, there are considerable diverse factors impacting on the students, not least being the cultural and environmental differences among districts.

After reviewing the evolution of primary curricula over several years, Abdaljoad (2004) concludes that curriculum development in primary school is limited to increasing or decreasing a subject hours’ allocation each week, or changing the title of a subject. Amendments to the curricula did not reflect the needs of the community, nor social or economic change.

Informed argument concludes science curriculum has not received appropriate consideration in Saudi education, being of secondary concern in primary classes.

For example, boys in the first grade are not exposed to science topics during their first semester, and in the second semester they have just one hour of science per week (Alssunbul et al., 1998, cited in Al-Abdulkareem, 2004). Given that early student exposure to science engenders interest from an early age, this curious outcome is all the more remarkable as students have 15 compulsory school subjects at primary level. Table 4-3 describes the paucity of science exposure for primary school students, being 7 per cent of total class time for grade one, 7 per cent for grades 2 to 4 and just 13 per cent for later classes.

Table 4-3 Hours of classroom study assigned to each aria

Aria	**Grade**						
	1		**2**	**3**	**4**	**5**	**6**
	Sm.1	Sm.2					
Religious studies	9	9	9	9	9	9	9
Arabic language	12	11	9	9	9	8	8
Social science	-	-	-	-	2	2	2
Mathematics	2	4	4	4	5	5	5
Science	-	1	2	2	2	3	3
Drawing	2	1	2	2	1	1	1
National education	-	-	-	-	1	1	1
Physical education	3	2	2	2	2	2	2
English						1	1
Computer skills							
Weekly class hours	28	28	28	28	31	33	33

(Ministry of Education, 2005b)

There are other issues impinging on science curriculum standards that affect students' performance. As noted above, science textbooks, despite attempts to modernise them, are outdated and there is an emphasis on theoretical science education, therefore neglecting experiments and practical activities. The textbook is divided into theory and implementation, thus dividing the fact from the illustrations;

as well, there are barriers between the scientific groups, making comprehension difficult for young students (Al-Abdulkareem, 2004).

Insufficient computer supplies to meet student numbers, particularly in non-urban regions, results in a lack of access to computers, or use of equipment (BouJaoude, 2003). Nashwan (1993) analysed the science curricula of eleven Arab countries, finding that science theory was preferred to practical applications which link science with everyday life. Students are not encouraged to use inquiry, problem-solving, or thinking skills. Other informed comment on science curricula is that students' attitudes, backgrounds and environments are not considered in curriculum formation, nor is attention paid to student creativity (cited in BouJaoude, 2003). The Ministry of Education retains control of school curriculum standards, and the private sector, which is not included in curriculum development, does not contribute sufficiently to the debate on restructuring education standards, or its delivery.

To illustrate restrictions on science curricula development from a personal view, Al-Abdulkareem (2004) describes his participation in reforming intermediate and primary science curricula:

> In 1999, Aldamegh and I, with some teachers, were assigned to develop science textbooks for intermediate school (K7-9), with only a few months' work period. The Ministry of Education delegated a team of nine educational supervisors, including me, to develop new science textbooks for elementary school (K1-6), putting authors in the same dilemma with time limitation (pp. 67-68).

In both situations the author asserts that "this change should be considered as a temporary development for science curriculum" (p. 67). However this *temporary* reform is still in place; primary and intermediate schools continue to use these textbooks as the sole reference for students and teachers, the latter required by policy to instruct according to this guide (Al-Sadan, 2000). The possible arguments to account for the less than substantial attempt at bringing science curriculum to an acceptable standard by a small team was caused by either the Ministry gaining authorisation for reform just at that time, or an insufficient budget to overhaul the curricula regularly to meet the continual changes in Saudi society. The resolution, however, is that for the former, as noted, developing school curricula is a responsibility of the Ministry of Education since establishment, and its budget exceeds $AU66,071 million per year. As noted, there is considerable work involved on the General Project for Curriculum development, commenced in 1999 and expected to be completed in 2002, thus more amendments are required.

Developing curricula is the responsibility of the curricula department in the Ministry of Education and occurs in isolation from other parts of the Ministry such as assessment and teacher training. As a result, teacher representatives are not consulted during the curriculum development process, nor do teachers in general receive appropriate training in new teaching styles and assessment methods aligned with amended science curriculum.

However, science curriculum development resides as one set of issues, whilst priorities and resources are others. Science's allocation of class time per week is an example of low official priority to the subject; the lack of well-equipped laboratories is an example of low resource allocation that meets science's standing in education. A limited weekly exposure to science for students precludes a focus on inquiry and problem-solving skills, particularly as the primary science curriculum has considerable material to absorb, for example seven integral units per semester for grade six.

4.3.2 Assessment in Saudi education

The following section concerns assessment practices in Saudi schools, discussing the evolution of the different forms, and noting the Ministry of Education and its predecessors' responses to the prevailing educational policies of the time.

4.3.2.1 Summative assessment

Historically, summative assessment which focuses on generating a result that reflects the student's performance was the dominant assessment practice in Saudi schools: the examination system was, and is, the first and only tool of educational assessment (Al-Sadan, 2000). This assessment policy dates from 1926 when the general educational department was established. The first change in the examination system, in 1929, relate to annual averaging of students' results for their three monthly examinations (Ministry of education, 1999). A more substantial change occurred in 1975, when the academic year was divided into two semesters, with two examinations for each subject and a year's result for each subject. The results for each subject are based on 70 per cent for the two written semester examinations, 20 per cent for mid-term tests, and 10 per cent for the student's participation in class and attention to homework. The final examinations for grades one and two subjects were oral, except for mathematics and science, whereas from grades four to six all examinations were written except for reading, and some religious subjects (Al-Sadan, 2000). The minimum pass mark for social and science subjects is 40 per cent, and 50 per cent for other subjects. If a student fails to achieve a minimum subject pass mark at the end of the year, a supplementary examination is available at the end of summer recess in that subject. However, if a student fails again to attain the minimum percentage, the whole year, including the subjects already passed, must be repeated (Al-Baadi, 1995).

The first significant changes to assessment occurred in 1999. The most important change is that students from grades four to nine are considered to achieve a general pass if they obtain 70 per cent of the minimum pass mark (that is, 28% for a 40% pass mark, and 35% for a 50% pass mark) in not more than two subjects, and religion and language subjects are not included.

Later, in 2006, students in intermediate levels, or the entry grade of secondary school, who fail to reach a qualifying mark in more than two subjects, can avoid retesting on two subjects of their choice on the condition that the student did not obtain less than 70 per cent of the minimum mark in each subject.

4.3.2.2 Continuous assessment

There is ambiguity in the concept of *continuous assessment*, not only among teachers but also among educational researchers, due to the absence of a clear definition in the assessment bylaw and its theoretical background. For example Al-Najim (1999) believes that *continuous assessment* is synonymous with *formative* *assessment* and elsewhere defines continuous assessment as that which is "used to judge a student's progress after finishing every part of the subject, with the aim of reporting whether a student masters this part or not" (p. 123).

In 1999, continuous assessment using alternative testing methods was imposed for the early grades from one to three. The syllabus of applied continuous assessment had three phases; the first was the initial experimental phase, when some primary schools were given a choice in the implementation of the new assessment method, starting in the first semester of 1998. The second, also experimental phase started immediately in the second semester with a large number of schools implementing the assessment system using defined methods. In the last phase, in 1999, continuous assessment was applied in all primary schools from grades one to three (Al Moied, 2004). The Ministry's objectives for using continuous assessment are:

- linking the assessment process with instructional procedures
- using authentic assessment in the classroom
- assessing student's performance in different situations during the semester
- applying criterion-referenced assessment approaches based on learning outcomes
- bringing students and their parents into the assessment process (Alhakami, 2004, p. 4).

Continuous assessment, as it is used in Saudi primary schools, is based on two factors; first, the teacher is provided with guidelines for each subject comprising framework, content, and standards of knowledge and skills expected of the student. Second, continuous assessment advocates a methodology which includes differential assessment so that a mix of means are used, reporting on student progress twice per semester, and sending an assessment report to the parents each time. Saudi policy on continuous assessment also allows the school council to consider individual cases of non-qualifying students for advancement to the next grade, remedial programs, or retention at the failed grade.

The first amendments to the continuous assessment bylaw occurred in 2006 as a response to “a comprehensive review of the previous bylaw of student assessment” (The Higher Committee of Education Policy, 2006, p. 3). Even though no substantial change in primary assessment methodology was decreed, continuous assessment has been extended to include grades four to six which will be implemented gradually from 2006 to 2009 (The Higher Committee of Education Policy, 2006). It is also suggested that replacing the mid-semester test in middle and secondary schools with many shorter tests during the semester, and the use of other forms of continuous assessment.

4.3.2.3 Assessment development evaluation

Despite an evolution of examination methodology spanning eight decades, summative assessment still dominates assessment practices in Saudi schools. The use of continuous assessment as a determinant of formative assessment over the past several years achieved mixed results in Saudi Arabia, with encouraging outcomes but barriers remain. A study by Al Daoud (2004) explored the views of 232 mathematics teachers and 68 supervisors in Riyadh City to identify issues relating to the use of continuous assessment. The researcher found that the methodology contributed to the focus on mastering basic skills, and the early identification of students with special needs, as well as identifying students' mathematical trends. On the other hand, the results show that teachers lack familiarity with the alternative assessment's evaluation techniques.

As part of the assessment bylaw implementation, the Ministry of Education's Office of Assessment and Measurement Direction (2001) compared the students' pass rates before and after introducing continuous assessment. The results showed that the pass rates decreased on average across all primary schools by four per cent for grade one classes, two per cent for grade two classes, and three per cent for grade three classes. At the annual meeting of Ministry of Education, the directors considered the introduction of continuous assessment and concluded that, in students' early learning in particular subjects, complex skill structures were involved and performances were difficult to assess (Educational Departments, 2001). The conclusions point also to deficiencies in teaching methods.

Al-Najim (1999) conducted a study to evaluate a continuous assessment methodology used for religious subjects in primary schools in Riyadh City. The study involved 1564 teachers and 42 supervisors. The result showed that 90 per cent of teachers in the sample did not receive structured training in educational assessment. Further, the goals for the continuous assessment methodology were barely achieved, with the exception of one result indicating a decrease in students' examination anxiety levels. Al-Najim's study found that the majority of teachers focused their assessments on low-level knowledge domains.

Similarly, Al-Ebarahim (2001) found that the implementation of continuous assessment methodologies does not take into account teachers' training needs, and critical elements of the assessment bylaw are ambiguous even with the addition of the explicatory guidelines. To remedy inadequate aspects of the bylaw, a large number of subsequent teacher instructions were issued. However, she asserts, further documentation did little to overcome difficulties resulting from firstly a lack of training for teachers and supervisors, and secondly a neglect in preparing school personnel for implementation of the new assessment. Other studies reached the same conclusions and also found that continuous assessment neglected to assess some essential skills, and was unsuitable for large numbers of children in a particular class (Al-Usaimy, 2002; Al Moied, 2004)

There is ambiguity in the concept of continuous assessment, not only among teachers but also among educational researchers, due to the absence of a clear definition in the assessment bylaw and its theoretical background. For example Al-Najim (1999) believes that continuous assessment is synonymous with formative assessment and in another position in his thesis defines continuous assessment as that which is " used to judge a student's progress after finishing every part of the subject with the aim of reporting whether a student masters this part or not" (p. 123).

To implement such assessment reform in Saudi schools successfully, previous studies recommend training teachers in new methods of assessment and teaching, and involving them in any redevelopment efforts. The studies also recommend reducing the number of students in the class; relief burden for teachers to allow them to follow students' progress more closely; and reducing the content of school subjects in order to transfer from traditional teaching and assessment methods to the new methods that focus on higher order thinking skills.

However, although the Ministry's 2006 amendments aimed at overcoming implementation issues, the bylaw nevertheless focused on directions and grade promotion details, rather than addressing the underlying identified constraints that impede the program. In fact, the Ministry has too many roles, it is policymaker, implementer, and arbiter of Saudi education; a combination of roles which impedes the regional educational departments in their ability to adapt the implementation decrees to achieve the policy imperatives, and thus they are arbitrated against for non-performance. The Ministry, without a consultative process to avoid foreseeable impediments, dismisses informed opinion and research results and pursues its own agenda. Therefore, the Shura Council (parliament) recommends establishing a national centre for assessing education to take the arbitration role as an independent observer (Alhakami, 2004b).

4.3.3 Teachers and teacher training

One of the biggest problems encountered by the Ministry of Education in the early stages, was the shortage in the number of the domestic qualified teachers (Ministry of Education, 2001). Three main policies have been adopted to deal with this shortage: (a) employing teachers from neighbouring Arab countries, such as Egypt, Jordan, Syria, and Sudan; (b) employing sometimes unqualified Saudi teaching and administrative staff; (c) establishing training facilities for domestic teachers. The qualifications of Saudi teachers have gradually improved over the years, as in their early years, the Ministry of Education and GAGE often recruited teachers who possessed no higher qualification than literacy (Al-Baadi, 1995).

The first training institutes for teachers were established in 1953 (Ministry of Education, 2001). These institutes originally offered a two-year program after elementary school, and later upgraded to provide a three-year program after intermediate school (Al-Baadi, 1995). To raise the standard of teacher proficiency, the Ministry opened two centres for complementary studies in 1965. It aimed to provide additional opportunities for inservice teachers to improve their educational skills, scientific knowledge, and teacher training for those in need (Aljabber, 2004). By 1990, there were 127 teacher-training institutes offering a three-year program, but the standard was below college level. In the same year, there were 40 post-secondary training institutes, mostly two-year junior colleges of education that were upgraded into four-year autonomous colleges of education. Of these post-secondary institutes, 22 serve males and 18 serve females (Al-Baadi, 1995). In addition, there are more than 10 university colleges of education that serve both genders. From the middle of the 1990s the teacher-training colleges graduate teachers that can not be absorbed in all majors except Mathematics, English and Computer Sciences. An increased number of teachers is due to the fact that Saudi teachers' remuneration is competitive with other service areas, with promotional opportunities and bonuses readily available (Abouhaseira, 1998; Al-Baadi, 1995). Recently, there were 18 teacher colleges serving males and 102 (15 provide just English and computer studies) serving females (The Ministry of Education, 2006). In addition there are more than 10 university colleges of education that serve both genders.

4.3.3.1 Professional development evaluation

There is little research available regarding teacher education and professional development programs in the country, and this is particularly noticeable regarding science teacher education and further training programs. “A major problem that faces any researcher while studying teacher education programs in some developing countries, particularly Saudi Arabia, is the lack of research, studies, and information resources” (Almaraee, 2003, p. 49). Available studies include an early questionnaire by Al-Wabil (1982) on teaching skills, professional education courses, and student teaching experiences. The questionnaire was distributed to 188 employed teachers from Umm Al-Qura University after a year’s teaching experience, and the findings were that graduates were satisfied with their overall training (as cited in Alhabis, 1997). Studying the views of 214 male student teachers at Umm Al-Qura University in 1989, Dairi (1990) asked their opinions of the student teaching program. The findings were that the students had little practical experience to improve their skills before starting to teach; they found difficulty applying theory to practice; and supervisors did not always provide adequate assistance, including a need to attend classes more frequently.

To evaluate aspects of the teacher education course at Imam Mohammed Bin Saud Islamic University (IMBSIU) in Saudi Arabia, Alhabis (1997) distributed a questionnaire to 603 students who graduated between 1981 and 1995, and the faculty members at the time of the study. The questions addressed teaching skills; practical training in classes; issues regarding the course, and suggestions to improve the course. The results showed that the participants did not acquire sufficient competencies related to curriculum and instructional media; that they were not satisfied with the standard of the course; they received insufficient individual attention to appropriately apply lecture material, and for student evaluation; and that the issue of most concern was that there was insufficient time to complete the course to an acceptable standard.

Studying science teachers' views regarding practising their profession, Al-Abdulkareem (2004) delivered a questionnaire to 298 science teachers and 31 science supervisors. The study result showed that although Saudi science teachers are aware of inquiry-based views regarding science, nature, and teaching science, they do not practise these views in science class. The findings of the study imply that, to succeed, educational reform in science must simultaneously address all the components of the system, and the concept of systemic reform, as well as addressing the need for a standards-based learning system. The researcher concluded that a curriculum reform project needs to set benchmarks for science curriculum in Saudi, and the structure of the reform should apply to a network, inclusive base instead of the existing hierarchical system. School-based ongoing workshops for teachers, and reshaping students and teachers' evaluation procedures, were also suggested.

4.3.3.2 Teachers' role in science education reform

Educators and researchers (Al-Abdulkareem, 2004; Al-Sadan, 2000; Alhabis, 1997; Almaraee, 2003) argue that in the Saudi education system teachers have a marginal role in educational reform, partially due to inadequate standards for their qualifications and a deficiency of professional development programs, and also because of a lack of hierarchical appreciation of their ability and dedication.

Aslam (1986) found that most teaching courses emphasised theory rather than practice, and the curriculum allowed supervisors inadequate time for their students (as cited in Alhabis, 1997). After reviewing several studies on teachers' courses in Saudi Arabia, Almaraee (2003) found that most studies were critical of the standards for imparting skills to the students, particularly in regard to teaching methodologies, and practical training. Recently Al-Abdulkareem (2004) found that the majority of students' text resources are out of date, examples being *Planning and developing scholastic curriculum*, written by Fekrey Rayyan in 1981, and *Contemporary curriculum*, a book written by Damerdash Sarhan in 1977. Other texts for "new theories in education" are the works of Kansan in 1958, Tyler in 1966, Neagly and Evans in 1957, Inlow in 1966, Johnson in 1967, Goodland in 1966, and John Michaelis in 1967. Al-Abdulkareem concluded that teaching courses do not address current debate or new approaches in education, and therefore teachers are not given the opportunity to participate in school science reform.

Teachers rarely receive professional development. As previously mentioned at s 4.3.3, they receive promotion based on length of service, not on performance; they are rarely demoted or lose their position, and so there is no incentive for teachers to improve their performance. Further, due to the constraints placed on their activities by the Ministry, teachers are not encouraged to undertake their own professional development, or to participate in training programs and practise the new methods in the classroom. During sampling procedures, I encountered quite considerable difficulty convincing some school principals to allow their science teachers to receive a two-week training program. As most training programs in school districts are run by co-workers with similar qualifications and experience to their audience, there is a risk that the information being imparted will not be acted upon and that there is no real transfer of skills and knowledge. Such trainers are promoted to supervisor rank and ‘professional development programs’ are part of their position description. Finally, teachers, as noted, receive information on science education reform, but this is not reinforced through teacher skill development either in curricula, or assessment of their productivity in their classrooms. The Ministry of Education, as central policymaker and implementer, imposes new projects without the resources nor policy framework for schools and teachers to successfully integrate the projects into the existing school system. An example of this lack of Ministry planning is that the new system is imposed across the country, regardless of the logistics in training sufficient teachers to implement it. In my experience as a supervisor in the Measurement and Assessment Department of the Ministry of Education, insufficient supervisors were trained in the school districts to allow even an awareness of the requirements of the new assessment methodologies to reach the teachers who were expected to excel in the application of those techniques. The Ministry provided insufficient training resources, and rather than the 42 districts, some ten districts were visited to train supervisors in a particular assessment project; a similar situation was experienced by the curriculum department. Al-Abdulkareem (2004) described his experience with teachers after developing primary science textbooks using inquiry and problem-solving methods:

> Teachers' critiques for these books concentrate on the short length of the book because they are used to giving the information directly to the student, so it did not take so long to finish the book using the lecture method instead of the suggested method (p. 68)

Implementing new reform methodologies, as the literature review asserts, requires consideration of teachers' beliefs, and individual training to master the new method, rather than that which actually occurred: insufficient knowledge to implement a *suggested* method.

Finally, educators (Al-Abdulkareem, 2004; Al-Sadan, 2000; Alabdelwahab, 2002) claim that in the Saudi educational system, as in other Arabic countries, there is a lack of trust by their superiors in teachers' performance and attitude. Teachers are therefore continuously monitored by school principals, and inspectors from the district office (Al-Baadi, 1995). Even though the educational supervision in Saudi Arabia has changed several times since 1956 (Al-Madhi, 2003), Al- Abdulkareem (2004) argues that the outcome of all these changes remains at the level of checking a teacher's systematic paperwork. Teachers do not have the authority to adapt their lessons and must adhere to the subject plan closely, using approved teaching methods. Al-Madhi (2003) observed that teachers expressed dissatisfaction with a supervisory system that could be detrimental to achieving their educational goals.

4.3.4 Summary

The first form of educational system in Saudi Arabia was the kutab where students learned basic writing and arithmetical skills in groups. In 1924 a Directorate of Education was established which was replaced later in 1953 by a new Ministry of Education. The Ministry of Education was given the specific task of expanding the national school system for males, and to give it a modern basis comparable with that of Western states (Al-Sadan, 2000). The government of Saudi Arabia has given substantial attention to education under the global slogan “Education for all”, and has allocated about 20% of the overall budget for k-12 education annually. therefore, the educational system in Saudi has made many successful strides over the past few decades, however it has encountered many challenges related to on one hand the quick changes locally and internationally in all the life aspects, and on the other hand, to the characteristic of the system itself. Many researchers (Al-Sadan, 2000; Bahgat, 1999; Rugh, 2002; Samman, 2003) argue that reforming Saudi educational system is not an easy task, partly because the educational system is centralised, and secondly, because there are serious obstacles facing development and change of the educational system. These relate especially to curriculum, assessment, teaching styles, and the learning process generally. Other researchers (Abdaljoad, 2004; Al-Ebarahim, 2001; BouJaoude, 2003) consider that the efforts directed toward the development of science curriculum and assessment practices were inappropriate and did not take into account the teachers’ professional development needs.

CHAPTER 5: METHODOLOGY

This chapter describes the study project including design, instruments, methodology, and participants. A multi-method approach is applied, using both quantitative and qualitative methods to reflect the multi-dimensionality of the research. This approach enables detailed analyses of the study project, performance-based assessment of Saudi primary school pupils in science classrooms, and the collection of rich information on its implementation, including the perspectives the participants have toward the project. For comparative research such as this, the validity and reliability of the instruments are critical. Therefore, the instruments used for quantitative analysis were developed and tested prior to data collection. The interview processes used in the qualitative section follow the typical conventions of the research literature regarding this approach.

5.1. Research Design

The design of this study utilised methodology reflecting a multiple methods approach within a research context. It was hoped that this would establish a clearer picture about what was going on in the research context (Maxwell, 1996). As Cresswell (1998), and Denzin and Lincoln (2003) claim, ethnographic accounts represent the different means by which individuals make sense of their experiences and describe the various types of social organisation. Therefore, for the qualitative analysis relating to this research, an ethnographic approach using thematic data analysis was used. This thematic analysis consisted of open-ended, semi-structured interviews with students and teachers, focused on the context in which students learn and teachers impart science knowledge. Qualitative data-gathering and analysis provided in-depth information that is beyond the scope of quantitative analysis. However, the employment of both types of analyses strengthened the research argument by providing a more complete picture of the study's themes, irrespective of the level of outcome support or contradiction between the two types of analysis.

The experimental approach of Pre-Post Randomised Group design , R--GP--O--T--O, R--GP--O------O (Observe, Treatment, Observe), was determined appropriate for the quantitative part of the research. Both the experimental and control groups were assigned at random and then a pre-test conducted before treatment began to ensure the similarity of the groups. For that a t test was conducted after investigating its assumptions to test the equivalency between groups. For homogeneity of variance of the groups, Levene's test was applied and the results showed that the two groups have equal variances in the science pre-test, F= 1.10, p =.296 >.05 and the SATSS, F=.827, p=.364 >.05 as shown in Table 5-1.

Table 5-1 Levene's Test for Equality of Variances

Pre-test	*F*	p
Science	1.10	.827
SATSS	.827	.364

Normality was tested by calculating simple descriptive statistics of the pre-test within each group to get skewness and kurtosis, and then these were divided by the relevant standard errors (see Table 5-2). The ratio of skewness or kurtosis to standard error should be within the +2 to -2 range (some authors use = +3 to -3) for a normal distribution. For both groups, the ratio of skewness to standard error of skewness, and the ratio of kurtosis to standard error of kurtosis in dependent variables ranged between 1.1 and -2 (see Table 5-2), that is, the data followed a normal distribution

Table 5-2 Tests of Normality

Post-test	Group	Sk*	Std. Error	Sk/SE	Ku**	Std. Error	Sk/SE
Science	Experimental	-.422	.207	-2. 04	.007	.411	.02
	Control	-.171	.207	-.83	-.751	.411	-1.83
SATSS	Experimental	-.094	.223	-.42	.503	.442	1.14
	Control	-.332	.212	-1.57	.082	.420	.20

**Skewness*
*** Kurtosis*

The result of the t test as shown in Table 5-3 indicated that there were no significant differences between the experimental (N = 137, M = 13.25, SD = 3.95) and control (N = 137, M = 12.86, SD = 4) groups in the science pre-test, t (272) = .800, p = .425 > .05. There were also no significant differences between the experimental (N = 118, M = 50.40, SD = 6.17) and control (N = 131, M = 50.11, SD = 6.97) groups in the pre SATSS, t (247) = - .328, p = .743.

Table 5-3 T test for dependent variables

Pre-test	**df**	**t-value**	**p**
Science	272	.800	.425
SATSS	247	-.328	.743

Therefore, the study groups were statistically equivalent in the dependent variables as measured by science pre-test and SATSS. However, as this study is based on mixed methods for data analysis, a set of study questions and hypotheses was formulated to articulate the qualitative analysis component, as described hereunder.

5.1.1 Research Questions

Q1. What are the differences between the type of science learning outcomes that can be achieved by the implementation of performance-based assessment and traditional testing methods?

Q2. Are student attitudes toward science affected by performance based assessment?

Q3. Are students' final science examination outcomes predictable through performance based assessment?

Q4. What are the differences between the teachers in their performance assessment competencies as measured by the Teacher Performance Assessment Questionnaire before and after their participation in the study project?

Q5. How does performance-based assessment work in relation to the Saudi primary school environment?

Q6. How do Science teachers evaluate their experience of training and using performance-based assessment?

Q7 How do students in 6^{th} grade evaluate their participation in implementing performance-based assessment?

5.1.2 Research hypotheses

H_0 1: There is no statistically significant difference between the experimental and control groups in the means of their scores in the final science exam.

H_0 2: There is no statistically significant difference in the means of scores between the attitudes toward science of the experimental and control groups.

H_0 3: Performance based assessment cannot predict final science examination scores of the experimental group.

H_0 4: There is no significant difference in the means of performance assessment standards of science teachers as measured by the Teacher Performance Assessment Questionnaire before and after their participation in the study project.

5.2. Study Sample

The processes of sampling involved random selection of six schools from of a list of boy schools throughout Riyadh City, within each school two Grade 6 classes were randomly selected and assigned to either a control group (N=143) or an experimental group (N=146) with a total of 289 students. Individual students in the sample were the units of analysis as described in Table 5-4. Due to absences of students from one or other of the pre-test or post-test, data for statistical comparison of only 274, 249 students were compiled on the pre-tests, and 265, 225 on the post-tests of science and SATSS respectively. The minimum and maximum ages of participating students were 10 years and 15 years respectively, with an average age of 12.18 years for the experimental group and 12.10 years for the control group. The student sample represented three different socio-economic levels in order to control the variables that might interplay with the independent variable, and the demographic characteristics of students who were involved in implementing the study were Saudis (91%) and other (9%) who were from different Arabic countires.

Table 5-4 Distribution of study sample

School	Group		Total Number of Students
	Experimental	Control	
1	26	22	48
2	21	21	42
3	23	23	46
4	20	19	39
5	29	31	60
6	27	27	54
Total	146	143	289

All the participating science teachers (N = 6) were Saudis and held Bachelor degrees in Education. They had experience ranging from 4-15 years full time teaching. The teachers in the participating schools taught both the experimental and control classes of students. To implement the study program, the teachers received comprehensive training for two weeks about a performance-based assessment approach. To meet the conditions of this research, a performance-based assessment approach was used for the experimental classes, whereas traditional assessment and teaching were used for the control classes.

5.3. Performance-Based Assessment Program

Following the tradition of performance-based assessment literature, a new program of performance-based assessment was prepared. The characteristics, principles, and requirements of this type of assessment were taken into account, so skilled science teachers were required to integrate student learning and teaching applications to enhance higher order thinking. Therefore, the program was comprised of three parts to encompass learning, teaching and assessing science with all parts framed around performance-based assessment. The components of the Performance Based Assessment Program are described below. To implement the study program the teachers received comprehensive training on a performance-based assessment approach for two weeks.

5.3.1. Units of Work Based on Performance Assessment

For the Grade 6 science classes in the six participant primary schools, two units, Electricity and Magnets, were redesigned for students based on a performance-based assessment approach (see Appendix A). The changes involved the structure of the lessons that contains the rubric, the context of the lesson, a self-assessment page for the students, and science lesson presentation instructions for the teachers. The units were comprehensively redesigned to enhance inquiry and problem-solving on science for performance-based assessment. The work content for the units is set out below.

For this research, each unit of Electricity and Magnets designed for the experimental classes consisted of six activities, described as investigations based on inquiry science that students complete in the classroom. Students used 'activity sheets', that is, written directions and aids for self-paced learning and the activities were undertaken either individually or in groups; however, all activities were designed for cooperative learning environments. Teachers for the experimental classes were focused on the role of a facilitator, intervening only in key moments without providing direct answers. The content of the units of work as shown in Figure 5-1 involved:

Figure 5-1 Performance Based Assessment Components

1. Activities

Each activity had student instructions and directions for the teacher. The student sheet described the main task and the students were provided with self-assessment forms. The teacher's instructions included the objective(s) and construction of the activity and some matters pertaining to the performance based assessment. Apart from the main task, the student sheet contained:

A. The Instructional Rubric: Student performance was assessed against a rubric for which criteria for assessment were based on the objectives of the lesson, and some essential learning elements.

B. The student's Self-Assessment Form: The self-assessment forms were simplified for the first activities to allow the requisite skills to develop.

2. Student homework

Teachers allocated homework to encourage students to acquire the basic scientific concepts for inquiry science. Such work outside the classroom also reinforced understanding of the concepts through practice of concepts within the activity and becomes more complex as the pupil's understanding grows. Science-based games were included for playing in a student's free time.

3. Student projects

Each unit included several projects which students could select according to their interests. Each project lasted two to three weeks and students were monitored by their teachers to ensure they followed the project schedule and were undertaking the work they were allocated. On completion of a project, students were selected to present their work individually, or as a group.

4. Student tasks

Each unit included two tasks that were administered at the end of each unit to assess progress in concepts and processes. Somewhat similar to the activity construction, the tasks were rigorous.

5. Student portfolios

Student portfolios contained samples of student work in the units covered, one activity dominating each week over other work such as projects and tasks for final assessment. The objectives of the Electricity and Magnets units were developed as a new approach focused on inquiry and problem-solving within a cooperative learning environment. Thus the traditional objectives for the two units were developed to align with essential learning elements involving the acquisition for students of two main components: knowledge and thinking skills, and communication skills. The first component aimed at developing inquiry strategies by students using the necessary thinking skills to develop an understanding of science and particular habits of mind to solve problems. The second component, communication, promoted the use of listening and observation skills in science classes and discussions to gain understanding, and also to use communication strategies and skills to work effectively with others (see Appendices A and B).

5.3.2. Performance-Based Assessment

As part of a new teaching and learning approach in Saudi primary schools, participating science teachers were instructed in planning, implementation, and monitoring of performance based assessment. As discussed in the literature review

(Chapter 3), teachers' prior belief structures can create issues in their performance outcomes when changing to a new teaching construct such as performance-based assessment. Teachers' perspectives on learning and assessment are explored in the review, and the findings of researchers calling for a reassessment of the benefits from sometimes non-productive belief systems absorbed from one generation of teachers to another are also discussed. To replace this inefficient and dated teaching and learning system, concepts of a constructivist learning approach are drawn from prior research findings, and elucidated through a suggested model, in anticipation that teacher practitioners are attracted by this approach and will embrace it. The components of performance-based assessment were illustrated in addition to the criteria of designing or choosing performance-based assessment tasks.

The three elements of assessment, teaching and learning, are dependent on a constructivist learning approach to embed assessment into learning and instruction whilst using strategies such as reasoning, communication, problem solving skills, and the conceptual understanding of science that reflect the new focus on higher order thinking. This approach was aimed at a change in teaching from rote-based learning to a greater dependence on students seeking out knowledge, learning through practising that knowledge, and acquiring skills in which they receive feedback from the teacher and for which they are assessed. The initial information package for teachers was supported by a number of empirical studies on the use of performance-based assessment in science classes to illustrate issues that arise and how they may be addressed. Further, the package, described teaching styles that encourage students to be reflective and self- regulated, with a focus on problem-solving and inquiry. Exploration was made of the program strategy which involves four elements including technique, assessment, performance, and time. A comprehensive explanation of each element (see Figure5-2) and usage guide developed for primary school science classes are presented in Appendix B.

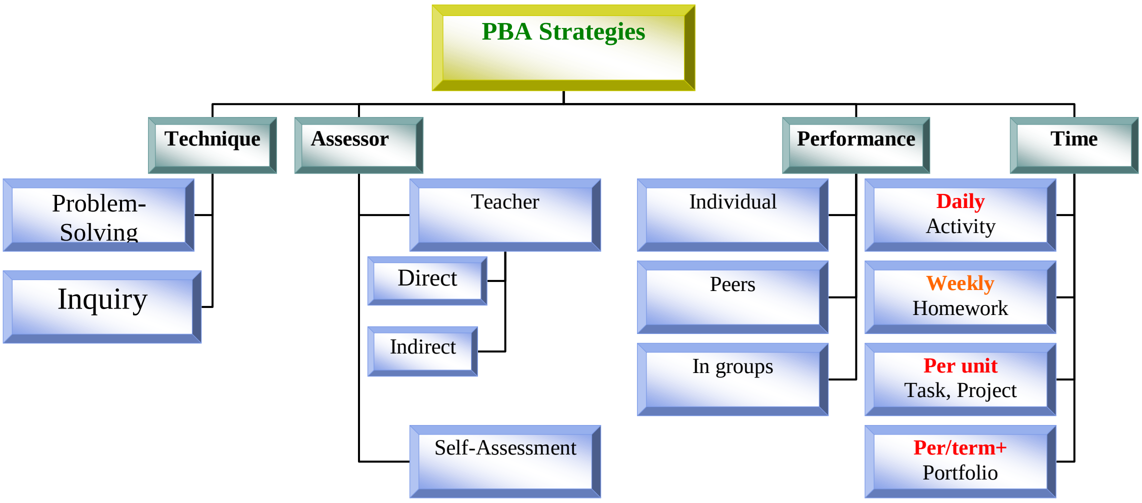

Figure 5-2 Performance-Based Assessment Program Strategy

5.3.3. Professional Performance Assessment Workshops

The initial information package for teachers on this study's performance assessment approach was followed by training to develop the teaching skills and especially the professional assessment skills of science teachers. The training involved eight workshops, each with three or four sessions in which teachers worked in cooperative groups for an hour, including presentations and group discussion. Material for the workshops was based on previous research findings on assessment training for teachers. Participants in the workshops were trained to integrate assessment procedures with science curriculum and instruction systems, design science lesson plans based on performance assessment, select and use different assessment strategies, design and implement activities and tasks that require higher order thinking by using problem-solving and inquiry constructs. They were also trained in a range of methods to assess students' performance, and in the use of assessment for formative assessment purposes (for more details see Appendix C).

5.4. Procedures

This research project was conducted in Riyadh City, the capital of Saudi Arabia. The Science Department, in the Riyadh Educational Direction, has eight sections in the city and has one or more primary school science supervisors in each section. Initially, contact was made with the Head of the Science Department to request permission for the research, and upon consent, nominate a number of primary school science teachers who would participate in this project. The Head of the Department agreed and, at a meeting with the Riyadh City science supervisors, distributed information on the study program with a brief explanation and asked each supervisor to identify and nominate three primary school science teachers. This was soon forthcoming and the Head of Science Department advised this researcher of the participating teachers and their schools. A meeting was held with the science teachers to inform them of the nature of the research and the contributions that were expected of them to implement the project. Ten science teachers were selected and their participation in the project training and implementation was approved by the Office of Educational Direction.

5.4.1. Program Content Methodology

The study participants, primary school science teachers, were trained in the performance-based assessment approach, for two weeks at the end of the first semester. The researcher attended these sessions each week. The study program was then administered in the first term of the second semester over a period of nine weeks, and delivered to Grade 6 primary students at their thrice-weekly science classes. Each lesson comprises a forty-five minute block of time during the school day which is from 7am-12:30 pm.

Prior to the onset of the research program, the Science Pre-Test and the Students Attitude Toward Science Survey (SATSS) were applied, that is, at the end of semester one for all Grade 6 science students in the participating schools. Each of two science classes in a school were randomly assigned (by flipping a coin) into an experimental or a control group; thus the six participating schools each contributed one science teacher, one experimental group and one control group. The Teacher Performance Assessment Questionnaire was administered to the participant teachers at the beginning of workshop training and again at the end of the study project. It was essential that teachers continue teaching and assessing the control classes by the traditional methods and avoid transferring any new experience from an experimental to a control class. Procedures were therefore undertaken to ensure that teachers retained traditional methods in the control groups, such as limiting learning materials to exactly the number of participating students in the experimental classes, requesting the science supervisors to inform this researcher of any perceptible differences in a teacher’s performance, and constantly reminding the participating teachers that outcomes for this study depended on the differentiation of teaching styles between the experimental and the control groups. Further, weekly visits by this researcher to each participant teacher ensured that teachers were vigilant in teaching process differentiation, and during the experimental periods, a weekly meeting with the team of teachers was held to discuss the study's implementation progress, issues arising during the week, and the teachers' forthcoming weekly plans.

The intervention study was restricted to the Electricity and Magnets units in the Saudi science textbook of Grade 6. It covered six lessons for each unit as shown in Table 5-5. So, the science content and objectives of the Units of Work in the study program for the experimental groups were aligned to the regular science curriculum of Grade 6 and were conducted as part of the regular timetable.

Table 5-5 Units lessons

Electricity Unit		Magnets Unit	
No.	Lesson	No.	Lesson
1	Attraction	1	Magnets
2	Static Electricity- Charges	2	The Power of Magnets
3	Making a Simple Generator	3	Magnet poles
4	Circuits	4	Compass
5	Conductors and insulators	5	Electromagnet
6	The benefits of electricity	6	Magnetic Force Field

Thus, variables relating to the school environment and the planned outcome for these science units under primary school conditions in Saudi Arabia were resolved. Further, the teachers reliably followed the constant and aligned teaching procedures for the six experimental science classes.

The teaching procedures used cooperative learning strategies for the experimental classes. At the beginning of each lesson, the teachers prepared materials for the activity and organised students into groups. The students read the instructions for the activity and then worked in pairs or in groups. At the end of each activity, students completed the self-assessment form. As well as class activities, students were given a choice to select the topic of projects for the unit, and were issued with information, a rubric and instructions for that project. The instructions involved discussing the outline of the project with the teacher, following the objectives and timelines set out, then forwarding a draft for feedback before submitting the final project; finally delivering a presentation to a group or the class.

As there were sufficient materials available only for class activities in pairs or groups, each unit contained two additional tasks for each student to complete and be assessed individually. The students then decided to include the activities in their final assessment in addition to the tasks and the project. All activity, project and task materials were then placed in the students' portfolios.

5.4.2. Instrumentation

The instruments used in this study to gather data for quantitative analyses include the following:

1. *Science Tests*

A science course pre-test was conducted at the end of semester 1 to examine similarity between groups. The test included 20 items related to a science student subject in Grade 6, taught prior to this study's program in semester 1. These items were prepared by the National Achievement Tests Committee to study the achievement progress of primary science in Grade 6 and were designed for students to complete within 35 minutes.

The science course post-test was a different measure from the pre-test measure because it had to include items that reflected the content taught during the intervention period. The content was limited to the Electricity and Magnets units that were covered in this research. The test consisted of 24 items adapted and developed by this researcher (see Appendix D).

Both the pre-science test and the post-science test were trialled by this researcher, among others, prior to their use in the actual research project. The trial determined the reliability of the tests. As a new instrument, the science post-test was submitted to three science specialists of the General Direction of Evaluation and Measurement, Ministry of Education, to review the constituent items for relevance and clarity. The comments of the reviewers were considered in developing the final form of the test. Both the pre-science test and post-science test were conducted on different occasions on primary school classes in Grade 6. The data were analysed to determine reliability by evaluating the Cronbach alpha coefficient. For the pre-science test, the Cronbach alpha coefficient was .72, (N=18), and for the post-science test was .71, (N=16). Nunnaly (1978) has indicated 0.7 to be an acceptable reliability coefficient, so that Cronbach's reliability coefficients for the science tests are acceptable.

2. *Student Attitude toward Science Survey (SATSS)*

To determine the attitudes of students toward science, a survey of 18 items was administered as a pre-test and post-test (see Appendix E), to 12 classes of Grade 6 students, representing both the experimental and control groups. Each of these items based on the Likert scale, had four possible responses from which the student chose by circling. The responses were Strongly Agree (4), Agree (3), Disagree (2) and Strongly Disagree (1). There were a number of negative items for which the scoring was reversed, randomly distributed throughout the survey.

The survey was developed from both TIMSS (1999b), and Century (2002), and translated into Arabic and then trialled on two classes of Grade 6 students (N = 43). The internal consistency of the survey was established using the Cronbach alpha coefficient and alpha, if item deleted (Cronbach, 1951). The alpha coefficient, if item deleted, and Cronbach alpha scores are displayed in Table 5-6. The result showed that removing any single item will not yield a higher alpha; therefore the items are sufficiently related to combine into an index. The overall alpha for the survey was .84.

Table 5-6 Cronbach Alpha Reliability Estimates for SATSS

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1	50.42	102.30	.68	.82
2	50.30	104.07	.62	.82
3	51.05	99.66	.52	.82
4	50.35	105.00	.47	.83
5	50.72	103.21	.41	.83
6	51.44	104.16	.38	.83
7	50.44	99.68	.68	.82
8	50.51	100.54	.56	.82
9	50.47	104.83	.47	.83
10	50.53	104.30	.41	.83
11	50.58	104.54	.32	.84
12	51.14	108.17	.29	.83
13	50.81	111.39	.12	.84
14	50.35	107.09	.37	.83
15	50.47	101.92	.55	.82
16	50.98	104.83	.40	.83
17	50.79	106.17	.30	.83
18	50.72	105.44	.40	.83
Alpha= .84			N= 43	

3. *Teacher Performance Assessment Questionnaire*

To study the experiences of the teachers regarding the applied performance based assessment program, the Teacher Performance Assessment Questionnaire was administered before the training program, and again at the end of the study. The questionnaire consisted of 30 items relating to four teachers' performance assessment standards: skill in both the design and choice of appropriate performance-based assessment tasks; skill in developing strategies to integrate appropriate teaching styles with assessment methods to obtain highly valued learning outcomes, skill in administering, scoring and interpreting the assessment result, and skill in using assessment results for formative purposes. The standards were divided into 17 sub-standards (see Appendix F).

The questionnaire was developed from the *Teacher Assessment Literacy Questionnaire,(1993)* by Barbara S. Plake & James C. Impara, University of Nebraska-Lincoln, in cooperation with The National Council on Measurement in Education and the W. K. Kellogg Foundation (cited in Mertler, n.d.), *The Standards for Teacher Competence in the Educational Assessment of Students* (American Federation of Teachers (AFT), National Council on Measurement in Education (NCME), & National Education Association (NEA), 1990). The competencies were originally developed to address the issues relating to inadequate assessment training for teachers (AFT, NCME, & NEA, 1990). A copy of the adapted questionnaire for this research was sent for review to four assessment researchers in science courses to examine the relevance of the items to the assessment competencies and the clarity of items. Comments and suggested modifications provided by the reviewers were analysed and considered in revising of the final instrument (see Appendix G).

4. *Interviews*

Qualitative data at the end of implementation was collected by interviews with both the students and the teachers. The interviews were recorded in a quiet room where the interviewees felt comfortable and were able to freely answer the questions. The interviewees agreed to be interviewed, and were amenable to the interviews being recorded. They were relaxed about the interview process and forthcoming in their replies. The interview sample involved two groups; students and teachers. Two students from each experimental class were selected at random; therefore there were 12 student interviewees. The second group comprised the six participating science teachers.

Each of interviewees was asked a set of semi-structured questions (see Appendix H). However, additional open-ended questions were used to obtain completeness of answers from the interviewees. Interviewees were encouraged to comment on their involvement in the study, particularly any negative comments, and whether these related to the study project or the learning environment.

5. *Assessment activities and tasks*

The activities and tasks typified the main component of the Units of Work, one part of the study program. They were used as an instrument to collect data for research Question Four, that is, to test the power of performance assessment to predict students' scores in the final science exam. A sample of activities and tasks were submitted for review to five science representatives from Victoria University and Melbourne University, Australia. Comments and suggested modifications provided by the reviewers were analysed and considered in revising the final instrument.

5.4.3. Data collection

Data were collected for both students and teachers before, and at the end of, Term 3. The pre-tests and post-tests of science and the SATSS were conducted by this researcher and each of the six science teachers at those times for both the experimental and control classes, whereas students' scores for science activities and tasks were gathered during the term. Similarly, data were gathered from the participating teachers in the beginning of the training workshops and at the last program meeting at the end of Term3. Qualitative data were collected via interviews with students (two students from each class) and all the science teachers in the last week of Term 3.

5.4.4. Data analysis

The quantitative data were analysed using SPSS, version 14 for quantitative analysis, and the QRS Nvivo for qualitative analysis. Due to using two different forms of science pre- and post-tests, the independent sample t test was applied to evaluate the first hypothesis (Ho 1), based on comparison of the means of scores for the experimental and control student groups on the post-science test. Before this, the independent sample t test was used in the exploratory analysis to ensure equivalency between the experimental and control groups on the science pre-test and on the SATSS. One-way ANOVA was also used to test hypothesis Ho 2, to measure the significance of difference between the experimental and control groups on the pre-administration and post-administration of the Student Attitudes toward Science Survey. For hypothesis three (Ho 3), the linear regression method was utilised to address the power of performance-based assessment in the prediction of students' scores in their final exam in science. A paired sample t test was used to examine hypothesis Ho 4, to highlight the difference between the teachers' performance assessment experiences before and after their participation in the study project

The qualitative data were analysed by using the QRS Nvivo. The data were categorised using the coding method. The student interviews data were classified into four tree nodes; differences between the old and the new methods, elements evaluation, effective factors and students' attitudes toward the performance assessment approach. The teachers' interview data were divided into five tree nodes including characteristics of the project, teacher responses, student responses, facilities and school community.

5.4.5 Translation of the study project and instruments

The study was conducted in the Arabic language in Riyadh City, Saudi Arabia, and since the study project and all instruments, except the science course pre-test instrument were written in English, translation was required. Several factors were considered in the process of translation including that the English version and the Arabic translation communicated the same concepts; that the translation was clear and understandable; and finally to certify the validity of the translation. To achieve these requirements, the material was translated into Arabic, then four Saudi postgraduate students specialising in English reviewed the translation in comparison with the original. The Arabic versions of the material were submitted to three representatives in science education and assessment from the Ministry of Education.

The Ministry representatives had studied abroad, and reviewed the translation for unfamiliar or confusing concepts such as “rubrics”. During meetings to discuss these issues, suggestions were made to use the translated themes that are involved in previous research to ensure consistency. The second key suggestion was to ensure that the students and teachers in the study were aware of the concepts being applied. Finally, the core of the study project (Units of Work) was evaluated by the participating teachers as part of the training workshops. This process contributed valuable insight into the successful application of the study’s concepts in a learning context for the students (see the main components of the Arabic version in Appendix I).

5.5 Summary

This chapter details the methodology and procedures of this study. After the research design was described, details of research questions, research hypotheses, and study sample were provided. The study project was then described in three parts. Finally, the procedures were then presented involving the program content methodology data collection, data analysis, description of instruments and translation of the study project and instruments. The adoption of these methods provided a sound foundation to obtain reliable and valid results which are presented in the next chapter.

CHAPTER 6: RESULTS

Chapter five describes the methodology used for this study, the content, the administration of the study project, and the development of evaluation instruments. This chapter presents the study results, which include both descriptive and inferential statistical analyses. Quantitative findings are presented in the first section, covering research questions 1 to 4. Qualitative results are presented in the second section of this chapter, covering questions 5 to 7. In each part, separate findings are given for each research question.

6.1 Quantitative findings

This section examines the quantitative findings from the study instruments. The instruments comprised science class pre-testing and post-testing, using the Student Attitudes Toward Science Survey (SATSS), and the Teacher Performance Assessment Questionnaire (TPAQ) respectively to collect the data for the analyses to address the research questions. Before presenting the analyses of data, the descriptive statistics will be presented.

6.1.1 Descriptive statistics

The maximum score possible on the science pre-test was 20, whereas on the post-test it was 24. The means of science achievement scores for both experimental and control groups are presented in Table 6-1. The means for the experimental group on the science test were 13.25 (*SD* = 3.95) in the pre-test, and 16.69 (*SD* = 3.49) for the post-test. For the control group, the means for the science pre-test were 12.86 (*SD* = 4), and the post-test 15.37 (*SD* = 3.55).

Table 6-1 Means and Standard Deviation for Groups on Science Tests

Group	*Science Pre-test*			*Science Post-test*		
	n	***Mean***	***SD***	***n***	***Mean***	***SD***
Experimental group	*137*	*13.25*	*3.95*	*136*	*16.69*	*3.49*
Control group	*137*	*12.86*	*4*	*129*	*15.37*	*3.55*

The distributions on the science pre-test for the experimental and control groups were near normal distributions, both with slight negative skew as shown in Figures 6-1,2. The scores ranged from 1 to 20; the experimental group had a sharp peak, where approximately 33 per cent of the experimental group scores were distributed between 14 and 16. In contrast, the control group scores, as shown in Figure 6-2, ranged from 3 to 20, and had two peaks: in the wider peak, 38 per cent of the scores distribution ranged between 14 and 18. The small peak comprised 23 per cent of scores distribution ranged from 10 to12.

However, in the science post-test, the frequency of scores for the experimental group was distributed in a range from 8 to 24, with a wider peak comprising 78 per cent of distribution of scores of the group that ranged between 13 and 23. The scores distribution for the control group as illustrated in Figure 6-2 ranged from 4 to 24 with a sharp peak from 14 to 16 comprising approximately 33 per cent of the distribution of the frequency of scores for the group.

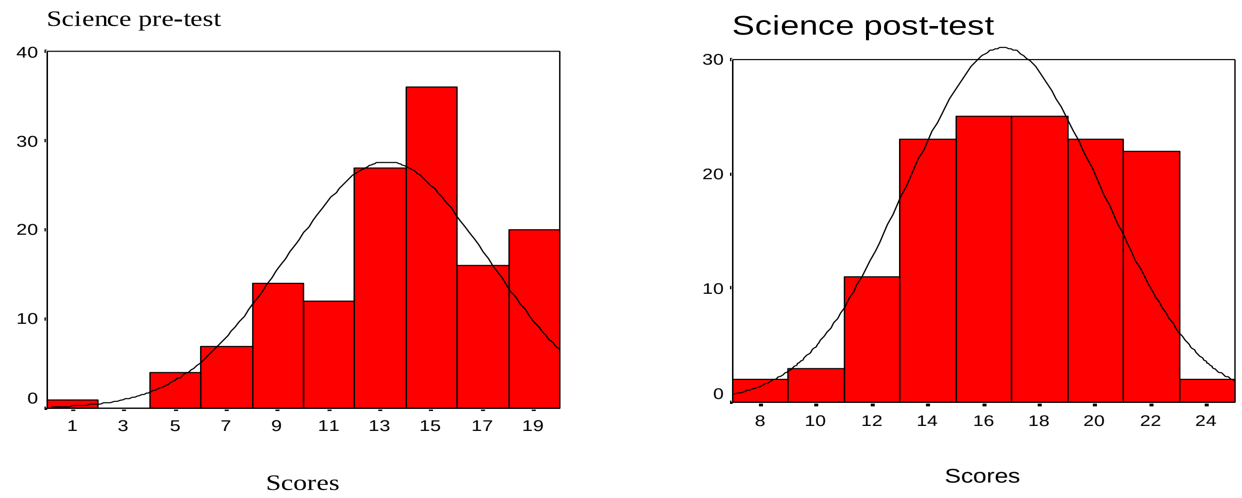

Figure 6-1 Histogram of Student Experimental Group Frequency Distribution on Science Tests

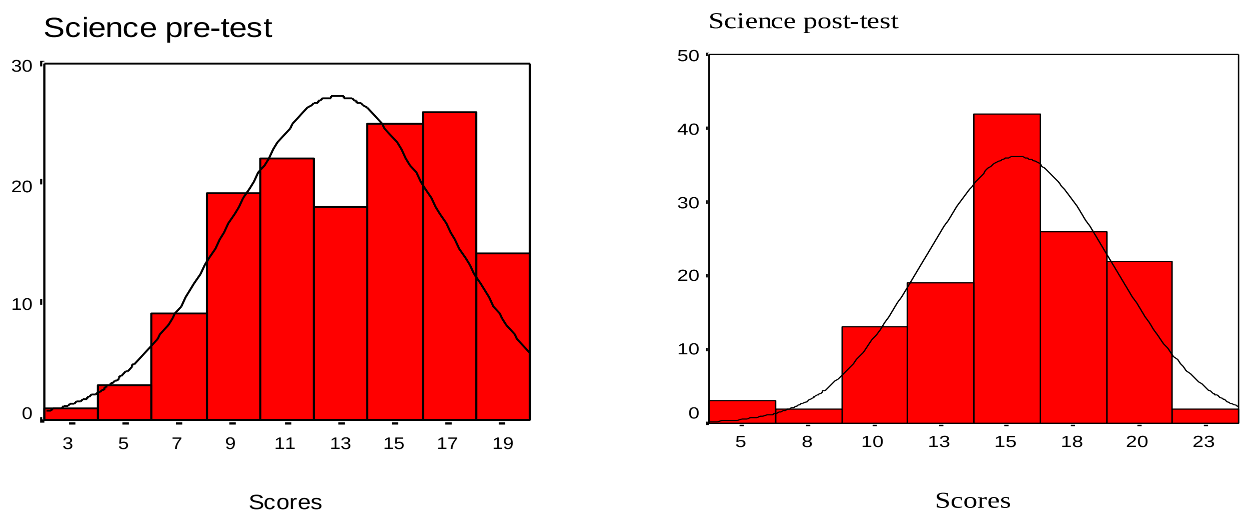

Figure 6-2 Histogram of Student Control Group Frequency Distribution on Science Tests

Table 6-2 represents the means of experimental group responses for the SATSS, which consists of 18 items. Responses were tabulated by using a four-point scale in both the pre-test and post-test. The comparison of means between the pre-test and post-test showed a generally positive change on the survey items (12 positive and 6 negative items). In the negative items[2] (3, 4, 6, 9, 13, 17), mean scores for the responses decreased in all items except item 13. The greatest decrease in student responses were .35 and .23, on items 4 and 9 respectively. On the positive items, student responses increased on all items. The highest responses were .49, .34, .32, .30 on items 11, 2, 7 and 5 respectively.

For the control group, the comparison between the student responses in the pre-test and post-tests (Table 6-3) showed that negative changes had occurred in 7 items, zero change in one item, and a modest change occurred in 5 items (<.1). Student responses to the negative items changed positively in all items with change in scores ranging from .08 to .46.

[2] The negative items were recoded to be consistent with responses for other items; i.e., ‘strongly accept’ is 1 whereas ‘strongly disagree’ is 5.

Table 6-2 Student Attitude Survey Responses, Experimental Group Pre and Posttest

Item	*Pre-test*	*Post-test*	*Change, Pre-post*
1. It is important to do well in science at school	*3.46*	*3.66*	*.20*
2. I usually do well in science at school	*3.36*	*3.70*	*.34*
3. Science is difficult	*2.76*	*2.91*	*.15*
4. I feel I am a lower achiever in science	*2.93*	*3.28*	*.35*
To do well in science at school you need:			
5. lots of natural (talent/ability)	*2.92*	*3.22*	*.30*
6. good luck	*2.33*	*2.43*	*.10*
7. I like science	*3.10*	*3.42*	*.32*
8. I enjoy learning science	*3.21*	*3.41*	*.20*
9. Science is boring	*2.89*	*3.12*	*.23*
10. Science is an easy subject	*3.05*	*3.28*	*.23*
11. Science is important to everyone's life	*3.19*	*3.68*	*.49*
12. I would like a job that involved using science	*2.68*	*2.72*	*.04*
13. Studying science makes me uncomfortable	*2.89*	*2.84*	*- .05*
14. I like doing experiments in science	*3.44*	*3.59*	*.15*
15. I want to learn all I can about science	*3.28*	*3.43*	*.15*
16. I like science better than before	*2.83*	*2.86*	*.03*
17. I don't like to do any activities in science	*3.13*	*3.24*	*.11*
18. Science lessons are my Favourite	*3.17*	*3.28*	*.11*

Table 6-3 Student Attitude Survey Responses, Control Group Pre-test and Post-test

Item	*Pre-test*	*Post-test*	*Change, Pre-post*
1. It is important to do well in science at school	*3.58*	*3.56*	*-.02*
2. I usually do well in science at school	*3.50*	*3.34*	*-.16*
3. Science is difficult	*2.61*	*2.96*	*.35*
4. I feel I am a lower achiever in science	*2.93*	*3.08*	*.15*
To do well in science at school you need:			
5. lots of natural (talent/ability)	*2.83*	*2.90*	*.07*
6. good luck	*2.00*	*2.46*	*.46*
7. I like science	*3.22*	*3.42*	*.20*
8. I enjoy learning science	*3.20*	*3.20*	*.00*
9. Science is boring	*2.90*	*3.02*	*.12*
10. Science is an easy subject	*3.02*	*2.98*	*-.04*
11. Science is important to everyone's life	*3.35*	*3.39*	*.04*
12. I would like a job that involved using science	*2.79*	*2.70*	*-.09*
13. Studying science makes me uncomfortable	*2.71*	*2.95*	*.24*
14. I like doing experiments in science	*3.33*	*3.36*	*.03*
15. I want to learn all I can about science	*3.48*	*3.33*	*-.15*
16. I like science than before	*2.95*	*2.79*	*-.16*
17. I don't like to do any activities in science	*3.11*	*3.19*	*.08*
18. Science lessons are my favourite	*3.15*	*3.21*	*.06*

The mean of teacher responses to the 30-question TPAQ increased from 12.17 (SD = 1.72) to 15.5 (SD = 2.88). With one exception, positive change occurred in teacher responses to the TPAQ between the pre-test and post-test. The changes in teachers' scores ranged from 1 to 8, as shown in Table 6-4.

Table 6-4 Teacher Group Coded Responses to Pretest and Post-test

Teacher	*Pre-test*	*Post-test*	*Change, Pre-post*
1	*11.00*	*19.00*	*8.00*
2	*13.00*	*14.00*	*1.00*
3	*15.00*	*18.00*	*3.00*
4	*12.00*	*13.00*	*1.00*
5	*12.00*	*12.00*	*.00*
6	*10.00*	*17.00*	*7.00*
Mean	*12.17*	*15.5*	

6.1.2 Inferential statistics

In this section of the quantitative analysis, the null hypotheses were tested. Null hypothesis one was examined by independent sample t-test to compare the means of differences of the experimental and control groups on the science post-test. Null hypothesis two was examined by ANOVA to compare the means of differences of the experimental and control groups on the pre- and post-test of the Survey of Students' Attitudes toward Science. For the third hypothesis, linear regression was used to address the power of performance-based assessment in the prediction of students' scores in their final science exam. For the fourth hypothesis, the paired sample t-test was used to highlight the differences between teachers' performance on the Teacher Performance Assessment Questionnaire before and after the study intervention. The level of significance employed for all tests of hypotheses was $p = .05$.

6.1.2.1 T test and ANOVA Assumptions

Statistical analyses were conducted to ensure that the required assumptions for the independent sample t test and analysis of variance procedures have been met. The assumptions are (1) independency, (2) normality, (3) homogeneity.

Independency

Independency is generally determined by the structure of the experiment from which they arise. Since the experimental and control groups in this study were assigned at random (see Chapter 5 for more details), all observations obtained from different participants could be assumed to be independent.

Homogeneity

The second assumption is that the variance of observations is equal across each group. To test the homogeneity, Levene's test was conducted for post-tests[3]. For the science post-test, the result of Levene's test of difference was not significant, $F(1, 263) = .036$, $p = .849 > .05$ (see Table 6-5). The result of Levene's test was also not significant for SATSS, $F(1,223) = 1.96$, $p = .163 > .05$. Thus, the science post-test and SATSS support the assumption of homogeneity of variance; which is, the variance is equal across groups, and therefore, the required assumptions of homogeneity of variance for the ANOVA procedures were fully met for the dependent variables.

Table 6-5 Test of Homogeneity of Variances for post-tests

Measure	**F**	**df1**	**df2**	**p**
Science test	.036	1	263	.849
SATSS	1.96	1	223	.163

[3] The assumptions of a t test for the pre-tests have been described in Chapter 5

Normality

The third assumption is that the distribution of observations for the dependent variable is normal within each group. The normality assumption was tested for each group by dividing skewness and kurtosis by their standard errors (see Table 6-2). A result between +2 and -2 is considered to constitute a normal distribution. The normality of the post-tests was evaluated for the science test and the SATSS.

For the science post-test, the ratio of skewness to standard error for the experimental and control groups was – 1.35, and - 2.08 respectively, and the ratio of kurtosis to standard error for the same groups was -1.34 and .70. For SATSS post-test**, (**as shown in Table 6-6) the results of ratios of skewness and kurtosis for the experimental group were -1.38 and 1.31 respectively, and for the control group were -1.35 and .43. Therefore, the required assumptions of independency, homogeneity and normality for the ANOVA procedures met the dependent variables (science achievement, and student attitudes) in post-tests occasions as well as in the pre-tests, as has been described in Chapter 5.

Table 6-6 Tests of Normality for Post-test

Post-test	Group	Sk*	Std. Error	Sk/SE	Ku**	Std. Error	Sk/SE
Science	Experimental	-.281	.208	-1.35	-.555	.413	-1.34
	Control	-.443	.213	-2.08	.297	.423	.70
SATSS	Experimental	-.317	.229	-1.38	.595	.455	1.31
	Control	-.304	.226	-1.35	.193	.449	.43

**Skewness*
*** Kurtosis*

6.1.2.2 Research question 1

The first research question concerned the effects of the study's performance-based assessment program on students' science achievement levels compared to those reached by traditional assessment methods. The question is: *What are the differences between the type of science learning outcomes that can be achieved by the implementation of performance-based assessment and traditional testing methods?*

$H_0$1: There is no significant difference between the experimental and control groups in the science post-test.

To test the null hypothesis that emanates from Question 1, the independent sample t test was applied. The result revealed significant statistical differences in the science post-test scores between the experimental (N= 136, M = 16.69, SD = 3.49), and control (N= 129, M = 15.37, SD = 3.55) groups, $t(263) = 3.05$, $p = .003 < .01$ (see Table 6-7). Therefore, the null hypothesis is rejected. The resultant effect size (.37) for the differences between the two groups shown in Table 6-7 was in the small range (Cohen, 1988).

Table 6-7 Independent Samples t Test for Science Post-test

Group	**Mean**	**SD**	**df**	**t value**	**P**	**E. S.**
Experimental group	*16.69*	*3.49*	*263*	*3.05*	*.003*	*.37*
Control group	*15.37*	*3.55*				

6.1.2.3 Research question 2

The second research question investigated the effect of the study project on the students' attitudes: *Does performance-based assessment have an effect on students' attitudes' toward science?*

$H_0$2: There is no significant difference in the means of scores between the experimental and control groups for the students' attitudes toward science.

Data for this variable was collected through the use of the Student Attitude toward Science Survey (SATSS) which was administrated at the beginning and the end of the study. The data collected from both the pre and the post administration of the SATSS for both the experimental and control groups (see Table 6-8). The data were analysed by one-way analysis of variance. The result as can be seen in Table 6-9 showed significant statistical differences in the post-test of the SATSS between the experimental (M = 51.17, SD = 6.12) and control (M = 49, SD = 7.10) groups, $F(1,223) = 6.08$, $p = .014 < .05$ with a small size effect (.33). Therefore, the null hypothesis that there are no statistically significant differences between the attitudes of the experimental and control groups toward science is rejected.

Table 6-8 Means and Standard Deviation for groups on SATSS

SATSS	Group	N	Mean	Std. Deviation
Pre-test	Experimental	118	50.39	6.17
	Control	131	50.11	6.97
Post-test	Experimental	111	51.17	6.12
	Control	114	49	7.10

Table 6-9 Analysis of Variance (ANOVA) for Science pre and post-tests

Measure	Source	df	F	p	E.S.
Pre-test					
	Between	1	.108	.743	
	Within	247			
Post-test					.33
	Between	1	6.08	.014	
	Within	223			

6.1.2.4 Research question 3

The third question investigated whether performance-based assessment results are predictors of student performances in the final science test. Specifically, the question asked: *Can performance-based assessments predict students' scores in the final science exam?*

$H_0$3: Performance based assessment cannot predict final science examination scores of the experimental group.

Data were collected through applying the study program's performance assessment in science classes, comprising six science activities, and two tasks for each unit. The students' achievements were scored for three activities, as well as both tasks for each unit, and were randomly collected from 10 students in each class. The final performance-based assessment scores were generated by averaging the individual scores for the ten activities and tasks. The capacity of performance assessment to predict students' scores in the final science exam was investigated by using linear regression analysis on the data from students' results on the performance assessment, and then from their final examination results. The result in Table 6-10 demonstrated that approximately 23 per cent of the variation in the final science test scores can be predicted by the performance-based assessment scores at < .05. The results of the linear regression analysis are summarised in Table 6-11. The relationship between performance–based assessment scores, and final science test scores shown in Figure 6-3 is a moderately positive linear relationship, r = .484.

Table 6-10 Linear Regression Coefficients for Performance-Based Assessment predicting final science test

Variable	**Coefficient**	**Std. Coeff.**	**t**	**p**
(Constant)	7.38	.484	2.723	.009
Performance assessment	3.11		3.984	.000
N = 54	R = .484	R^2 = .234	Std. Error.= 2.96	

Table 6.11 Analysis of Variance

Source	**SS**	**df**	**MS**	**F**	**p**
Regression	138.94	1	138.94	15.876	.000
Residual	455.06	52	8.75		

Figure 6-3 Linear Relationship between Performance Assessment and Final Test Scores

6.1.2.5 Research question 4

The fourth research question highlighted the difference between teachers' performance on the Teacher Performance Assessment Questionnaire (TPAQ), before and after the study procedures: *What are the differences between the teachers in their performance assessment standards before and after their participation in the study project, as measured by the Teacher Performance Assessment Questionnaire?*

$H_0$4: There is no significant difference in the means of performance assessment standards of science teachers as measured by the Teacher Performance Assessment Questionnaire before and after their participation in the study project.

Before testing this hypothesis, the main assumption of paired t-test was examined. Normality was tested by calculating simple descriptive statistics of the pre-test for skewness and kurtosis, and these were then divided by the relevant standard errors (see Table 6-12). The ratio of skewness or kurtosis to standard error should be within the +2 to -2 range for a normal distribution. The ratio of skewness to standard error of skewness, and the ratio of kurtosis to standard error of kurtosis in dependent variables ranged between .802 and -1.32 (see Table 6-12), that is, the data followed a normal distribution.

Table 6-12 Tests of Normality

Test	***Sk****	***Std. Error***	***Sk/SE***	***Ku*****	***Std. Error***	***Sk/SE***
Pre-test	*.678*	*.845*	*.802*	*.814*	*1.74*	*.468*
Post-test	*.000*	*.845*	*0*	*-2.30*	*1.74*	*-1.32*

**Skewness*
*** Kurtosis*

The scores for participating teachers (n = 6) on TPAQ, before and after receiving training and participating in the study project, were analysed by paired samples t-test at Table 6-17. The results indicate that the mean score for teacher performance increased from 12.17 (SD = 1.72) to 15.5 (*SD* = 2.88). However, they did not reach a statistically significant .05 level, $t = -2.41$, $p = .06$, effect size = 1.3, power = .49. Therefore, the null hypothesis that there are no significant differences in the performance assessment competencies of the science teachers as they are measured by the TPAQ between pre-test and post-tests is accepted. The detailed analysis is displayed in Table 6-13.

Table 6-13 Paired sample t-test for TPAQ, teacher group

Std. Deviation	**Std. Error Mean**	**t**	**df**	**Sig. (2-tailed)**	**E.S.**
3.386	1.382	-2.411	5	.061	1.30

6.2 Qualitative results

6.2.1 Teacher interviews

The interviewees' data addressed the participating science teachers' responses to the implementation of the study project, and whether Saudi primary schools are receptive toward a performance-based assessment approach. The teacher interviews involved two research questions, each of which was divided into sub-questions, described further in this section.

Research question 5: *How did science teachers evaluate the implementation of the study program in their schools?*

Research question 6: *Is the Saudi primary school environment receptive to a performance-based assessment approach?*

As described in Chapter 5, the responses to these questions were obtained at the end of the study project from recorded teacher interviews. After reviewing the audiotapes from the teacher interviews, formulating Arabic transcripts and English language translations of the transcripts, the resulting data were imported as rich text format (rtf) into the computer software package QRS NVivo. The themes inherent in research question five, shown in Table 6-14, were divided into five tree codes: characteristics of the project which has five child codes (differences between the traditional (old) and performance assessment (new) methodologies, advantages and disadvantages of the study project, and difficulties; teacher responses, divided into two child codes (attitudes, and professional development); and student responses, divided into two child codes (attitudes, and gained benefits). For research question six, the data were divided into two tree codes: facilities, and school community. The first theme was also divided into three child codes: laboratory, training materials, and library, and the second theme was likewise divided into two child codes: principals and teachers.

Table 6-14 Qualitative Categories, Codes, and Examples from Teacher Interviews

Tree codes	Child nodes	Sibling nodes	%	Examples from Teachers Interviews
Characteristics	Differences	New/this method		This method was far better than the old one
		Old method		Students in the old method just listened to the teacher
	Advantages	Active	67%	Students … were very quiet in the class and they began to be very active
		Interactive	67%	The advantage is the interaction of students
		Responsible	50%	Students are taking responsibility for their learning
		Discovering	17%	In the new method a student discovers a fact by himself
		Low achievers	33%	The low achievers … have been participating in the class, moving, asking questions
		Creative	83%	this method also inspires students to be creative
	Disadvantages	Time consuming	100%	It needs time for preparing materials
		More effort	100%	The program needs more effort from the teacher
		Exhausting	67%	This new method is exhausting
	Difficulties	Teaching load	100%	I teach 24 hours a week
		Time limit	100%	I do not have enough time to follow up the students
		Facility shortage	67%	The difficulties are that we don't have a lab
		Correction	100%	Another main difficulty is how to correct student activities
		Class size	50%	The main difficult I faced is the large number of students
Teachers' responses	Attitudes	Enjoyed	83%	It was enjoyable work
	Professional development	Learning/ Benefit	83%	I've gained new experience which I can benefit from
Student responses	Attitudes	Like/ Respond well/ /Love/ Enjoyed	100%	Students enjoyed the new method
	Achievement	Gained benefits	83%	They become cooperative and had discussion in useful ways
Facilities	Lab	Inappropriate Lab	83%	We do not have lab; what we have is just a class.
	Materials	Materials/ equipment	100%	For a long time we have needed more equipment in the lab
	Library	Library/ Books	100%	Science books are few and very old
School Community	Teachers	Teacher role	33%	The teachers can help by giving 5 minutes before the science lesson
	Principal	Principal/ School administration	33%	The role of the school principal is to reduce numbers of teacher's lessons per week

6.2.1.1 Research question 5

How did science teachers evaluate the implementation of the study program in their schools?

The question was divided into the following sub-questions:

6.2.1.1.1 Sub-question 5.1

What are the main differences between the old (traditional assessment) and the new (performance assessment) methods?

This question was structured to encourage teachers to consider and analyse their experiences regarding student assessment approaches; and to engage the teachers' interest for the following questions, focussing on the advantages and disadvantages of performance assessment. The new method as discussed in the theoretical component of this dissertation (Chapter 2) and the study project for teachers (s5.3) is based on the use of performance-based assessment as an integrating methodology within a constructivist instructional model that offers students in the primary science classroom opportunities to be active learners. In contrast, the previous assessment methodology of science teachers depends heavily upon traditional methods of teaching, where student assessment is separated from instruction and applied at the end of the unit or a period of time; and where teaching is based on the roles of teacher as sender, and students as receivers of knowledge.

From comparison of the two methods, teachers identified and clarified the main features of each. The interviewees reflected on traditional assessment throughout the training and implementation periods, as was planned. Their conclusions were that the previous assessment methodology is teacher-centred, that the role of a teacher is to transmit information to students in a controlled classroom situation which limits the development of students' abilities. By contrast when students are offered the opportunity to be more active with performance assessment methods, the teachers reported that students became more involved in their own learning. For example, Teacher 1 said that *in the old method, students just listened to the teacher* (Interview s3.1.2, paragraph115), whereas Teacher 5 described the new method by saying *students are in the centre of learning processes, students do everything themselves such as making an experiment, and teachers play supervision roles, guide students and show them the points they perhaps don't recognise* (Interview s3.1.3, paragraph157). These new roles have been confirmed by Teacher 2 who compared the old and the new roles of teachers and students:

> *The teacher is an advisor and a facilitator. Whereas in the old system the teacher feeds the students' data, makes the experiments, writes the result, and then displays it to the students, so the students in fact just receive information from their teacher. By contrast, the student now performs the experiments, deduces the result, and the teacher facilitates and advises, and gives some hints without giving a direct answer* (Interview s3.1, Paragraph 77-78).

The teacher interviewees' common view, after reflection on both methodologies, was a preference for performance assessment, or the new method. The teachers made clear statements about the new approach:

I think it was a successful experiment, in my opinion it is a worthy experiment (Teacher 2, Interview s3.1, Paragraph 72).

It was a good program (Teacher 3, Interview s3.1.1, Paragraph 102).

This method was far better than the old one (Teacher 6, Interview s3.1.4, Paragraph 163).

6.2.1.1.2 Sub-question 5-2

What are the advantages and disadvantages of using the performance-based assessment approach?

Teachers in interview mentioned several advantages, and some disadvantages, related to the new performance assessment approach. The teachers reported that students were more active, interactive, worked cooperatively in groups, and became more responsible for their own learning. In addition, the new method encouraged students, as well as their teachers, to use critical thinking skills. Moreover, the low achievers were encouraged to fully participate with their groups. One teacher mentioned that *students had some difficulties at the beginning, but later they really were very interactive* (Teacher 6, Interview s3.1.4, Paragraph 166). Another teacher made this comment:

> *I was surprised by some students who were very quiet in the class, and they began to be very active, they brought materials and made electrical generators, asked for some books, so I interacted with them, and gave them some books about electricity* (Teacher 4, Interview s3.1.2, Paragraph 120).

An advantage of performance assessment observed by teachers was enhanced student development. Teacher 1 mentioned that *in the new method, a student discovers a fact by himself* (Interview s3, Paragraph 56). This situation appeared to another interviewee to be atypical behaviour by students, who were used to receiving scientific facts direct from their teachers, and the interviewee commented that *Most students started working… [they] are asking some unusual questions, and presenting creative ideas* (Teacher 5, Interview s3.1.3, Paragraph 157).

Many teachers observed that students were more interactive, as Teacher 6 commented *The advantage is the interaction of students* (Interview s3.1.4, Paragraph 163). This interaction, as Teacher 5 mentioned, involved *all students, the low achievers with the high achievers* (Interview s3, Paragraph 65). As a result, according to Teacher 1, low-achievers were encouraged to participate, and to be active in the class: *Even the low achievers or those who are in the back of the class have been participating in the class, moving, asking questions* (Interview s3, Paragraph 54).

Moreover, some teachers noted students displayed responsibility for their learning, acted freely in the classroom, and worked in groups, discussing the work. One teacher commented that the performance assessment method is *Training students to discuss, and present, and take more freedom in the class compared to the previous situation in the traditional method where students were tightly controlled* (Teacher 5, Interview s3, Paragraph 65). Another teacher mentioned that the study project had many advantages such as

> *Students are taking responsibility for their learning, and learning to work in groups. Compared with the traditional method which measured only a low level of skills, just memorising, now you can measure all skills, such as conducting an experiment* (Teacher 2, Interview s3.1, Paragraph 89).

In addition, a majority of teachers indicated that the new method encouraged both students and teachers to use their abilities in many different and creative ways.

For example, Teacher 3 reported that *The best thing in this program is that students learn by themselves, and the teacher tries his best, and wracks his brains ... thinking of new ways to improve students' learning* (Interview s3.1.1, Paragraph 107). Teacher 4 noticed *In this method students begin working in groups, they write much more than before and this method also inspires students to be creative* (Interview s3.1.2, Paragraph 115). Teacher 5 revealed *Some students are starting thinking more deeply about their work than the curriculum presumes* (Interview s3.1.3, Paragraph 150).

Nevertheless, teachers reported disadvantages with the performance assessment method. All teachers reported that the new method is time consuming, needs extra effort, is difficult to correct, and does not suit a class with a large number of students. They considered time a major obstacle for implementing the study project, commenting *It is time consuming; it needs time for preparing materials* (Teacher 1, Interview s3, Paragraph 69); and *Implementing the program needs more time* (Teacher 2, Interview s3.1, Paragraph 83).

The second disadvantage is extra effort from teachers to prepare the materials, to manage the class, and to correct students' work. The teachers found:

> *It requires more effort* (Teacher 2, Section 3.1.2, Paragraph 115).
>
> *The program needs more effort from the teacher. He needs to be more active in the class and supervise students while they work in groups* (Teacher 3, Section 3.1.3, Paragraph 159).
>
> *It requires high effort* (Teacher 1, Interview s3.1, Paragraphs 78).
>
> *This new method is exhausting* (Teacher 6, Interview s3.1.4, Paragraph 168).

As the students’ work is based on rubrics, another disadvantage for teachers is the difficulty of correction. This was repeated in many comments:

The most important difficulty is correcting the activities (Teacher 4, Interview s3.1.1, Paragraph 108);

Another main difficulty is how to correct students’ activities, the teacher needs help in this matter (Teacher 1, Interview s3.1.4, paragraph 159).

6.2.1.1.3 Sub-question 5-3

What were the other difficulties faced whilst implementing performance-based assessment in your school?

All teachers linked the difficulties they faced to disadvantages noted in s.6.2.1.1.2 above, and also to the school environment. They reported that issues included other duties, time limitations, and the provision of facilities. All teachers had many duties -both class-related and extra-curricular-making their work in implementing the program more difficult. A Saudi primary school science teacher’s workload consists of 24 science lessons a week, about 5 lessons a day; each lesson takes 45 minutes, with no breaks between them. For example, Teacher 5 said *I struggle with implementing the program. I faced some obstacles, such as the timetable. I’ve 24 lessons, and I do not have enough time to follow up the students* (Interview s3.1.3, Paragraph 153); while another teacher remarked *The correction of students' work was difficult because I teach 24 lessons a week* (Teacher 6, Section 3.1.4, Paragraph 169).

In addition to these matters, inadequacy of school facilities (discussed in s.6.2.1.2.1), the limitation of science lesson time, and the large number of students in each class were issues faced by teachers implementing performance-based assessment.

All teachers reported that the limited science class time of 45 minutes was insufficient for students to undertake science lessons in the new method, particularly with a large number of students. Teacher 2 said *implementing the program needs more time, 45 minutes is not enough* (Interview s3.1, Paragraph 83). Another teacher reported the time limit as a main difficulty: *The difficulties are restrictions of time, paucity of materials, and the difficulty of correcting students' work* (Teacher 4, Interview s3.1.2, Paragraph 125). Teacher 6 stated that *the main problem is the limitation of time* (Interview s3.1.4, Paragraph 163).

Some interviewees observed that, in addition to time constraints, the teachers had a large number of students in their classes. For instance, Teacher 6 said, *The main difficulty I faced is the large number of students* (Interview s3.1.4, Paragraph 169). Teacher 1 asserted that *The large number of students doesn't suit the program, and the lesson time is too short* (Interview s3, Paragraph 69); and Teacher 2 suggested that *Implementing the program requires fewer numbers of students, between 15-20 students* (Interview s3.1, Paragraph 83).

6.2.1.1.4 Sub-question 5-4

How do you describe your attempt at using performance-based assessment in your classrooms?

Although teachers experienced difficulties with features of the project and the school environment, surprisingly most enjoyed participating in the study project. For example, Teacher 3 said, *To me it was enjoyable work, even though it was extra hard work* (Interview s3.1.1, Paragraph 102), and another teacher said *I enjoyed this method but it requires more effort* (Teacher 4, Interview s3.1.2, Paragraph 115).

Teachers attributed their enjoyment to the benefits gained for their students and themselves. A majority of interviewees reported noticeable professional development as a result of participating in the study project in science classes including activities such as formulating open-ended questions, running group work, designing experiments, and using assessment formatively. Teacher 4 revealed this about his participation:

> *I like the experiments, therefore I found myself enjoying my participation in the program, and I'm going to continue using the same method; the task idea especially is fantastic. Also, for some of the experiments, like the mystery board and Magnets table, I tried to design experiments but I could not formulate the questions. Now I have learned how I can do it* (Interview s3.1.2, Paragraph 144).

Another teacher made this statement:

> *I've gained new experience which I can benefit from, I can formulate some lessons by this method, and I'm going to continue to use group work. Indeed, cooperative learning is obviously a good experiment, and* (it) *delivered a good result. Also, I gained some information about formulating the lessons and questions which really demonstrate to what extent students understand* (Teacher 2, Interview s3.1, Paragraph 97).

Interviewees identified areas where they have improved; for instance, one teacher mentioned:

> *For me, I learned something about group learning, also how to advise a student and comment on his work in an encouraging manner which is less likely to affect him negatively, and in this way it is easy to distinguish inactive students from others* (Teacher 1, Interview s3, Paragraph 72).

Teachers reflected on students' roles in the classroom, as Teacher 3 said, I have been thinking about how students can take responsibility for themselves instead of explaining every single thing to them (Interview s3.1.1, Paragraph 111).

6.2.1.1.5 Sub-question 5-5

How do you think students responded to implementing performance-based assessment?

In terms of students' responses to the program, teachers' interview data indicated that participating students responded well, enjoyed doing science, and benefited from the experiment. The enjoyment of students is reflected in a number of teachers' comments: *Students enjoyed the new method* (Teacher 2 , Interview s3.1, Paragraph 85); *Most students are responding well to the program* (Teacher 6 , Interview s3.1.4, Paragraph 166); *Students' responses are very good* (Teacher 1, Interview s3, Paragraph 63).

As a result of the performance assessment program, all teachers reported that students appeared to have an enhanced enjoyment of science lessons. One teacher said, *I noticed that compared to other classes they love science very much* (Teacher 5, Interview s3.1.3, Paragraph 150). Another teacher said, *They are interacting with the program and they like it* (Teacher 1, Interview s3, Paragraph 63). Teacher 6 made this statement:

> *Students become motivated to attend the science class and they are always asking* what we are going to take today*, and when we finish the lesson, they ask* what are we going to take tomorrow*? ... I feel they bind themselves to the subject much more than before* (Interview s3.1.3, Paragraph 157).

Teachers linked students' preference for science class to the real benefits they gained from advantages of performance assessment methodology described in s6.2.1.1.2. For instance, Teacher 3 said *I've noticed that most students' answers on the self-assessment sheet showed they like their work because it is rich and enjoyable* (Section 3.1.1, Paragraph 102). Teacher 2 made this comment, *They become cooperative and have discussions in useful ways* (Interview s3.1, Paragraph 85).

6.2.1.2 Research question 6

How suitable is the Saudi primary school environment for application of a performance-based assessment approach?

6.2.1.2.1 Sub-question 6-1

Do you think the school facilities such as the laboratory and the library support the implementation of performance-based assessment in your school?

All teachers in the participating primary schools reported a shortage of science books, and curriculum materials. Further, a majority of the interviewees reported that laboratories are inappropriate, compounding the teachers' difficulties. For instance, Teacher 3 mentioned that *The library is very small, and science books are few and very old* (Interview s3.1.1, Paragraph 106). This situation was reported by a majority of interviewees: Teacher 1 said, *We have a library, but it has just a few old* *books, and those are presented in an old manner which is out of date* (Interview s3, Paragraph 61). Teacher 5 confirmed that by saying, *Unfortunately all our schools lack what are called modern science books. What we have is just an archive of very old books* (Interview s3.1.3, Paragraph 156).

The teachers also mentioned a similar situation for science laboratories and indicate all schools have inadequate laboratories and a scarcity of relevant curriculum materials. One teacher said, *The rented building that we are in now has an inappropriately small lab* (Teacher 3, Interview s3.1, Paragraph 82). However, teachers in permanent government-owned buildings are similarly constrained for resources, Teacher 5 said, *We do not have a lab; what we have is just a class, but by personal efforts we have tried to make it like a small lab* (Interview s3.1, Paragraph 82). Further, science laboratories, as noted by all interviewees, have insufficient curricula materials which led an interviewee to observe: *For a long time we have needed more equipment in the lab. We have requested this from the education department but have received no answer* (Interview s3.1.4, Paragraph 164). Others have provided curriculum materials from their own resources; Teacher 2 claimed that, *Sometimes the teacher has to provide materials himself* (Interview s3.1.1, Paragraph 106).

Importantly, science laboratories, particularly in the rented primary schools which were built for residential purposes, do not have adequate safety procedures. In the words of Teacher 3, *We are in a rented school which is different in many ways from governmental schools, particularly in safety procedures* (Interview s3.1.1, Paragraph 106). Often rented schools do not have the space for a laboratory, forcing science teachers to use classrooms for inappropriate purposes for science lessons. As Teacher 1 explained, *The difficulties are that we don't have a lab, and an appropriate place to mentor students, and sit down individually with each one* (Interview s3, Paragraph 70).

6.2.1.2.2 Sub-question 6-2

What role do you think the school community (particularly principals and teachers) played in the implementation of the performance-based assessment project?

Few interviewees considered other school staff members, particularly principals and teachers, as playing supporting roles in the implementation of the new method. Others, however, were unsure about what role other staff members should play. For example, Teacher 1 said:

> *The principal and other school staff play a secondary role. The role of the school principal, for instance, is to provide the necessary materials and consider the circumstances of implementation; the teacher's role is to be cooperative and to be patient with students* (Interview s3, Paragraph 59).

Teacher 4 said: The role of the school principal is to reduce the teacher hours per week, and provide the materials; the teachers can help by vacating the classroom five minutes before the science lesson (Interview s3.1.2, Paragraph 134), whereas Teacher 2 said I don't have any idea about the role of other teachers (Interview s3.1, Paragraph 81).

6.2.2 Student interviews

An objective of this study is to address the views of sixth grade science students on participating in the study project. Data were gathered through conducting interviews with students at the end of the study project. The protocol for interview was illustrated in Chapter 5. Two students were chosen randomly to represent each class (n=12).

6.2.2.1 Research question 7

How do students in sixth grade science view their participation in the performance-based assessment study?

The research question was broken down into four sub-questions:

1. *What are the differences in your science classes between this semester and the previous semester?*
2. *What do you think about the elements of the new method?*
3. *What are the most important things you like and dislike in studying science this semester?*
4. *Would you like to study science in the next semester in the same way as this semester? Explain your answer.*

However, additional questions were asked when necessary to elaborate students' answers. The sub-questions and responses were grouped under four tree codes (see Table 6-15) including the differences from students' point of view between the new and the old methods in learning and assessing science, students' evaluation of the main elements of the new approach, the factors affect their attitudes toward performance-based assessment, and their attitudes toward using performance-based assessment.

Table 6-15 Qualitative Categories, Codes, and Examples from Student Interviews

Tree codes	***Child nodes***	***Sibling nodes***	***%***	***Examples from Teachers Interviews***
Differences	*Teacher-centered method*	*Reading*	*58%*	*The teacher asked us to read the science*
		Writing	*67%*	*We wrote in the exercise book and answered the questions*
		Textbook oriented	*67%*	*We were studying everything from the book*
	Student-centered method	*Active participants*	*100%*	*This semester is better, because we are performing the experiments*
		Understanding	*92%*	*By making experiments, we understand and go deeper in studying our subjects*
		Cooperative Work	*58%*	*This method is fantastic, because we… work cooperatively*
		Engage lower achievers	*25%*	*In this method all students benefit and they create new ideas*
		Self-organised	*50%*	*The main difference is that in this method we depend on ourselves and test our abilities*
Elements evaluation	*Rubrics*	*Helpful*	*33%*	*It helps me to know whether I got excellent or good grades*
	Self-assessment	*Reflective*	*83%*	*It lets a student reflect on his own work*
		Risky	*17%*	*I do not like the self-assessment because it may upset the teacher.*
	Portfolios	*Keepers*	*58%*	*I put my science book and other stuff in it*
		Reflective	*33%*	*I review some of my work in the portfolio from time to time*
	Projects	*Self-motivation*	*50%*	*A student can work on something he really likes and feel confident for what he has done*
		Creative task	*25%*	*It helps us to devise something*
	Group work	*Encouragement*	*83%*	*All of us are participating, and the leader of the group encourages everyone to participate*
Effective factors	*experiments*	*Make experiment*	*67%*	*I like everything but I like making experiments the most*
	Group work	*Working cooperatively*	*33%*	*The favourite part is the cooperation*
Attitudes toward Performance Assessment approach	*Like*	*Engagement*	*100%*	*I would like to continue; this method helps you to understand, no matter what your ability is*
		Self-efficacy	*50%*	*I would like to continue because it is easy; there is nothing to memorise and no difficult questions*

The question 7 was divided into four sub-questions as follow:

6.2.2.1.1 Sub-question 7.1

What are the differences in your science classes between this semester and the previous semester?

This question assisted in establishing students' views of performance assessment, as compared to their traditional assessment procedures. In their answers, students identified differences between the new and the old methods. They described the old method as teacher-centered in which the students' role was limited to listening to the teacher, and doing what they were told, usually reading or writing; while they viewed the new method as student-centred, giving them the opportunity to be active participants in the science class. For example, students found that

> *In the first semester we were studying from the science book, whereas in this semester we use our minds. More students are performing experiments by themselves, and thinking* (Student 1, Interview s9, Paragraph 102).

> *This semester is better, because we are performing the experiments, whereas in the last semester there were no experiments. The teacher asked us to read the science book but now we can understand by ourselves (*Student 2, Interview s2, Paragraph 13).

During an interview, a student described the teaching processes in the traditional method as follows: *The teacher explained to us, and wrote on the board, and used to ask us to rewrite it in the exercise book* (Student 2, Interview s6, Paragraph 61). The majority of students stated that the science book was the main resource for learning, so the teacher asked them to read it, and try to answer the questions at the end of each unit:

> *The teacher usually asked us to read the science book* (Student 2, Interview s2, Paragraph 13).
>
> *We were studying everything from the book (*Student 3, Interview s4, Paragraph 40).
>
> *We wrote in the exercise book and answered the questions which are in the book* (Student 10, Interview s6, Paragraph 61).
>
> *We were just reading the science book* (Student 11, Interview s5, Paragraph 51).

The problem with this traditional method, students asserted, is that they could not understand science properly from reading the science book or writing in the exercise book. For instance, Student 4 found that *In the previous method we just wrote but we did not understand* (Interview s12, Paragraph 174), and another student said, *In the first method we were studying everything from the book; some students did not understand what they read* (Student 3, Interview s4, Paragraph 40). The interviewee explained *In the book there were some ambiguous aspects we did not understand* (Interview s4, Paragraph 40).

By contrast, all students found in the new performance assessment method a great opportunity to participate actively in the science class, and learn by themselves. Undertaking experiments, students explained, helped them to understand science better, as the following observations demonstrate:

> *We understand better with working* (Student 5, Interview s8, Paragraph 87).

> *We read the instructions make the experiments, and understand* (Student 3, Interview s4, Paragraphs 41).

> *In this method we understand more by making experiments* (Student 4, Interview s12, Paragraph 154).

> *By making experiments, we understand and go deeper in studying our subjects* (Student 4, Interview s12, Paragraph 154).

> *In my point of view, this method is much better, because the practical things are established in* (my) *mind and they might benefit us in the future* (Student 9, Interview s11, Paragraph 139).

Students also found performing activities or experiments based on group work encouraged them to work cooperatively, and help each other to understand, rather than working individually as before. The majority of the student interviewees considered this collaboration the prime difference between the two assessment methods. Students reported that:

> *The difference is that now I can answer the questions by myself, and with my group of five students, I can discuss with them, and then we can develop a common answer, whereas in the previous method, everyone was working alone, and writing the answer in his exercise book* (Student 6, Interview s3, Paragraph 29).

> *This method is fantastic, because we make experiments, work cooperatively,… in this method there is cooperation whereas in the old one there is not, everyone sat at his desk, and wrote.* (Now) *one student brings a new idea, and another one brings a different idea, and so on, if someone's answer is wrong, another student corrects it for him* (Student 12, Interview s 2, Paragraph 170).

As a result of cooperative work, underachievers were encouraged to fully participate with their groups.

> *In semester one* (the class) *was normal, the students who were not good at science couldn't understand the lesson, because the teacher didn't give them attention, he usually focuses on the high or middle achievers. In this method, all students benefit, and they create new ideas* (Student 7, Interview s10, Paragraph 123).

Further, students revealed that they became self-organised in their study rather than depending on their teachers. For instance, Student 2 mentioned that *We are doing activities by ourselves* (Interview s2, Paragraph 13), and Student12 said *The main difference is that in this method we depend on ourselves and test our abilities* (Interview s12, Paragraphs 181). Growing student independence therefore impacted on the teaching style, which changed as follows:

> *The teacher used to help us to answer the questions, now he just helps us to understand the questions* (Student 11, Interview s5, Paragraph 51).
>
> *In the past when the teacher explained the lesson, he didn't show how and why something happened, whereas now the activities involve many questions which benefit students and let them understand better. The activities provide students with various experiments that form information in the mind much more than the science book* (Student 7, Interview s10, Paragraph 123).

6.2.2.1.2 Sub-question 7-2

What do you think about the elements of the new method?

This question addressed the important components and forms of performance-based assessment used in the study project, in addition to the initiative of working in groups. The bases for performance-based assessment were the rubrics, the content of activity, and self-assessment. As discussed in s5.3.1, the rubrics were set out on the first page of the activities book as a guide for students and as assessment criteria for teachers. The self-assessment instrument was located on the last page of each activity to assist students in evaluating their work.

Students found rubrics useful for improving their work. For example, Student 2 said, *It helped me when I wrote ... I got a mark…it is like a guide* (Interview s2, Paragraph 17), while another student said, *I read it; it can help to promote my performance* (Student 4, Interview s12, Paragraphs 165). Other students referred to the rubrics after doing the activity to check their performance level, such as Student 5, who stated, *It helps me to know whether I got excellent or good grades* (Interview s8, Paragraph 92). However, some students did not refer to a rubric when they started work, and when one student was asked *Do you think it is important to see it before working on the activity?*, the reply was in the negative, while another student said, *I directly opened the next page* (Student 7, Interview s11, Paragraph 144). This may be because some students believe *It is for the teacher to grade students' work* (Student 10 Interview s6, Paragraph 65).

The majority of students paid considerable attention to the self-assessment compared to the rubrics, and all students perceived the self-assessment as helpful. Some students considered self-assessment more important than the teachers' assessment, as Student 7 stated, *This method is better than a teacher assessment, because the teacher couldn't understand the student better than the student himself* (Interview s10, Paragraph 125). Most students found self-assessment useful because:

It gives us an idea of our own level (Student 2, Interview s2, Paragraph 15)

> *It lets a student reflect on his own work; I mean concentrate on what he's done* (Student 9, Interview s11, Paragraph 140).
>
> *A student can realise his level, it helps me to see my level* (Student 10, Interview s5, Paragraph 51).
>
> *Instead of the teacher grading, you can grade yourself, it is better to assess yourself…you will know what you have or haven't done* (Student 10, Interview s6, Paragraph 64).

Although students realised self-assessment was useful, they had concerns about using it. For example Student 6 stated:

> *The self-assessment is a good method. For example, if one student's level is quite low, when he writes his level on the sheet the teacher can look at it, and help him. However, some students are afraid of showing their real levels (*Interview s*3, Paragraph 32).*

Student 3 provided explanation for the above observation when he said

> *I do not like the self-assessment because it may upset the teacher. However, self-assessment has something good, and something bad. To me, there are answers to some questions that I wouldn't like anyone to read (*Interview s*4, Paragraph 43),*(and perhaps) *students may give themselves a 4* (out of possible 4) *(*Interview s*4, Paragraph 45).*

In addition to the activities, important forms of performance-based assessment were projects, and portfolios. The interviewees agreed with the use of a portfolio in science class because *We put our things in them* (Student 8, Interview s12, Paragraph 154); *I put my science book and other stuff in it* (Student 4, Interview s12, Paragraphs 163); and *It keeps our papers neat* (Student 1, Interview s9, Paragraph 111).

Of note, students used a portfolio to review their work from time to time:

Once the teacher gives them (back) *to us, I look at my previous work to see whether I have some mistakes, and then* (fix them and submit*) it again* (Student 6, Interview s3, Paragraph 32).

We put our papers in it, and check it when the teacher allows us to take it home (Student 12, Interview s12, Paragraph 187).

I review some of my work in the portfolio from time to time (Student 7, Interview s10, Paragraph 127).

In addition, Student 9 suggested that The portfolio is a good idea, because the parents may consult it to know about the progress of their son (Interview s11, Paragraph 142).

The second form of performance-based assessment was the project. Students reacted positively to performing project work, because we enjoy them, they take a part of our time but we learn from them (Student 6, Interview s3, Paragraph 32). In addition, students found other considerable advantages to the projects:

A student can work and give his best, students sometime want to give more to expose their abilities (Student 7, Interview s10, Paragraph 165).

Because you can work in an area you like (Student 3, Interview s4, Paragraph 43).

A student can work on something he really likes and feel confident in what he has done (Student 9, Interview s11, Paragraph 140).

However, other students went further and suggested that:

It helps us to devise something; I think it will pave the way for us, when we grow up we might devise something better (Student 10, Interview s6, Paragraph 65).

> *It gives the student an opportunity to work with electricity, and when he grows up, he might be an electrician* (Student 12, Interview s12, Paragraph 188).

As discussed in s 5.3.3 students generally worked in groups on elements of performance-based assessment, response to this interaction was a priority of this study. The interviewees' answers indicated that students were enthusiastic about working in groups. For instance, Student 9 said, *I obviously like group work* (Interview s11, Paragraph 140), and Student 4 stated that, *I'm comfortable with my group. It is a good idea; I have not heard about it before. We worked cooperatively* (Interview s12, Paragraph 162). Students elaborated on their answers with different examples, such as:

> *In the group work my peer might remind me of something, or if I don't understand something, he could explain it and all of us will understand and if someone makes a mistake, another one can correct him* (Student 9, Interview s11, Paragraph 140).

> *All of us are participating, and the leader of the group encourages everyone to participate* (Student 11, Interview s5, Paragraph 51).

There were, however issues to group work. A group leader observed: Working in a group is a very good method but the problem is that the workspace is quite small, and some students didn't participate. The interviewee continued: *As I am the leader of the group I have to encourage them to participate. When someone didn't speak, I asked him to read, and if he refused, I asked another student beside him to read* (Student 3, Interview s4, Paragraph 44).

6.2.2.1.3 Sub-question 7-3

What are the most important things you like, and dislike in studying science this semester?

Although the students approved of all aspects of the study project, they had preferences. The majority of students liked performing experiments under performance assessment conditions:

I like everything but I like making experiments the most (Student 4, Interview s12, Paragraph 156).

I like the experiments. Everyone can enjoyably perform an experiment (Student 3, Interview s4, Paragraph 43).

The best thing is performing experiments and doing science at school (Student 8, Interview s12, Paragraph 176).

Some students gave explanations for their preference for experiments:

In this method you work, not your teacher. Now if you asked, any student will explain to you how magnets work (Student 12, Interview s12, Paragraph 186).

I like the experiments that we made. The experiments in the book are weak and useless whereas the experiments through the activities are much more helpful (Student 7, Interview s10, Paragraph 126).

I can do what I want, the teacher lets me do what I want, if I make mistakes he does not give me a low mark … in all lessons, the teacher takes care of us, and lets us discuss (things)*, so nothing is difficult* (Student6, Interview s3, Paragraph 31).

I like performing experiments, we are doing experiments as scientists do, and maybe one of us will become a scientist (Student10, Interview s6, Paragraph 63).

As noted, students' second preference was working cooperatively in groups. For example, Student 5 found that *the best thing l like is participating with students, working, and reporting our work* (Interview s8, Paragraph 89). Student 11 said that *the favourite part is the cooperation;* he added, *Everyone is willing to participate, every student even if he was lazy he is now active, because he sees … that other students are working* (Interview s5, Paragraph 51).

6.2.2.1.4 Sub-question 7-4

Would you like to study science in the next semester in the same way which you have in this semester? Explain your answer.

All students expressed a desire to continue using the new method in their science class. In addition to the two initiatives referred to in the last question, making experiments and working in groups, a further reason emerged as a reflection of students' satisfaction about their engagement in their learning activities, which is, a majority of the interviewees felt that they are able to understand science. For instance, Student 11 said, *Yes, I would like to continue; this method helps you to understand, no matter what your ability is* (Interview s5, Paragraph 54). Thus, they viewed science as having no real difficulties for them, as Student 3 said: *I would like to continue because it is easy; there is nothing to memorise and no difficult questions, and all students like performing experiments* (Interview s4, Paragraph 45). These views encouraged students to learn more about science, for example one student stated: *Yes, I would like to continue with the new method, because I want to discover things I did not know before* (Student 2, Interview s2, Paragraph 21).

Students' ability to manage their own learning influenced their self-esteem, which changed their view of learning, Student 6 commented *I feel I'm an adult, the teacher lets me answer the questions myself* (Interview s3, Paragraph 35). As a result, students are confident they can learn by themselves with a little help from a teacher: *I would like to continue using this method, because students are able to understand by themselves with no need for the teacher to explain it to them* (Student 10, Interview s6, Paragraph 67). Therefore, the attitude change of students can support self-efficacy development.

6.3 Summary

The findings of the quantitative analysis showed that there was a significant difference between the experimental and control groups in the means of their scores in the final science exam. Also, there was a statistically significant difference between the attitudes of the experimental and control groups toward science. The result of linear regression showed that performance-based assessment can predict 23% of the variation in the final science test scores. However, the findings also indicated that there were no significant differences in the performance assessment standards of the science teachers as measured by the Teacher Performance Assessment Questionnaire (TPAQ), between pre/post-tests.

The findings of the qualitative analysis revealed that the main trend determined from comparing the new and the old methods was favorable towards the new method. Teachers came to believe that the old method, whereby a teacher transmits information to students in a tightly controlled classroom which limits the development of students' abilities, was teacher-centred. In contrast, with the new method, teachers found that students become more involved in their own learning when they are offered the opportunity to be more active. Teachers mentioned several advantages and disadvantages to the new method. They reported that students in the experimental group were more active, interactive, worked cooperatively in groups, and became more responsible for their own learning. In addition, the new method encouraged both students and their teachers to use critical thinking skills. Moreover, students who were traditionally low achievers were encouraged to fully participate in their groups.

On the other hand, the major disadvantages mentioned by teachers were that the new method is time consuming, requires extra effort, is difficult to correct and does not suit a large class. Teachers linked the difficulties they faced to the disadvantages mentioned above and to the school environment. They revealed that most difficulties were all related to school-day duties, time limitations, and the providing the necessary facilities.

However, teachers enjoyed participating in the implementation of the study project because there were benefits for both them and their students. They reported noticeable professional development as a result of participating in the study project in science classrooms particularly, in terms of formulating open ended questions, running group work, designing experiments and using assessment formatively. They also indicated that the participating students responded well, enjoyed doing science and benefited from the experiment.

Teachers reported that the participating primary schools have a general shortage of science materials and science books. Most of them also reported that labs are inappropriate which adds to the difficulties that teachers already experience. In terms of the role of the school community in reform efforts, teachers did not recognise the active role for school staff, particularly principals and other teachers.

In a view that corresponds to their teachers, students perceived the old method as a teacher-centered method, where their role was limited to listening to the teacher and doing what he wanted them to do, usually reading or writing. They viewed the new method as a student-centred method which gave them the opportunity to be active participants in the science class. They mentioned that under the traditional method a science textbook was the main resource for learning; the teacher asked them to read it and try to answer the questions at the end of each unit. The problem with this traditional method, students asserted, is that they did not always understand science properly from just reading the science book or writing in the exercise book.

In the new method, students found a great opportunity to participate actively in the science class and learn by themselves. Students also found that the method of performing activities or making experiments based on group work encouraged them to work cooperatively and help each other to understand, instead of working individually as in the old method. Students had different perspectives about rubrics; whereas they gave considerable attention to the self- assessment and perceived it as a good method, they were also content with using a portfolio in the science class. Students reacted positively to conducting projects. The part they liked the most was performing experiments and working cooperatively in groups. Even though all students reported that they would to continue using the new method in their science class, they mentioned different reasons, related to cognitive and personal aspects that supported the general development of self-efficacy.

CHAPTER 7: DISCUSSION

This thesis examined a performance assessment approach to the professional development of primary school science teachers in Saudi Arabia. The study used adapted grade 6 science curriculum content for specific units in Saudi schools. It focused on the effects of the performance-based assessment intervention on students' achievement, and their attitudes towards science, as compared to a control group of their peers. Additionally, the study examined the participation of science teachers, and the effects of the intervention on their professional development. The outcomes from the study have significance for Saudi policymakers, in its assessment of the country's educational environment and its state of preparedness for reform driven by performance-based assessment. The finding of this study is that the use of a performance assessment approach leads to improvement in both learning and teaching outcomes in the science classroom. In a discussion on educational reform, Stiggins (2002) reported that a country's leaders ask basic questions on student assessment, viewing it as a tool for reward or punishment to increase teachers' and students' performances. The answers the policymakers receive will certainly affect schools, but unfortunately the impact from that advice will not always be positive. Stiggins continues that the questions the leaders overlook, that should be asked are: "How can we use assessment to help all our students want to learn? How can we help them feel able to learn? Without answers to these questions, there will be no school improvement" (p. 1).

This chapter comprises a discussion of the research findings, with quantitative and qualitative outcomes both addressed. This thesis was guided by the following questions:

Q1. What are the differences between the type of science learning outcomes that can be achieved by the implementation of performance-based assessment and traditional testing methods?

Q2. Are student attitudes toward science affected by performance based assessment?

Q3. Are students' final science examination outcomes predictable through performance based assessment?

Q4. What are the differences between the teachers in their performance assessment standards as measured by the Teacher Performance Assessment Questionnaire before and after their participation in the study project?

Q5. How does performance-based assessment work in relation to the Saudi primary school environment?

Q6. How do Science teachers evaluate their experience of training and using performance-based assessment?

Q7 How do students in 6^{th} grade evaluate their participation in implementing performance-based assessment?

7.1 Discussion of quantitative findings

Inter alia, this empirical study compares quantitative results from the performance assessment intervention for the experimental student group, to the results of the control group. Analysis is limited to the total scores on the pre-and post-science tests rather than on individual items. The focus of the study was in relation to over changing students' overall performance in science. In this study, quantitative analyses support the research hypotheses, with the exception of the science teachers' outcomes, where it is assumed there is no significant difference between pre-testing and post-testing in the science teachers' performance assessment standards, as measured by the Teacher Performance Assessment Questionnaire (TPAQ). Quantitative outcomes indicate that statistical significant differences between the grade 6 students who received the performance-based assessment intervention and those in the control group can be attributed to the research treatment.

7.1.1 Learning science outcomes

A priority for this study was to determine whether the use of a performance-based assessment approach showed a marked result for grade 6 science students' achievement scores. For this purpose, independent sample t test was applied to examine the difference between groups. The result indicates that the mean differences between the two groups were significant at $< .05$ level with) in favour of the experimental group, with an effect size (.37) indicating greater positive development in science performance with the experimental group. The time frame of 9 weeks) for implementing the study intivantion may have limited the magnitude of the effect size. So, it suggests that a performance-based assessment approach could promote and support students' learning in science taking into consideration the necessary time period for students to master cognitive skills that involve higher order thinking. This result is consistent with a considerable body of research (e.g., Biondi, 2001; Enger, 1997; Parker & Gerber, 2002) that has found that performance-based assessment supports learning science.

Evidence from the descriptive analysis (Chapter 6, Figure 6-1) shows that performance-based assessment supports low achievers. In the science pre-test the experimental group had a sharp peak with 33% of the distribution ranging between 14-16 scores, whereas in the post-test it had a wide peak occupying 78% of the whole distribution with scores ranging between 13, 22. Therefore, performance-based assessment methodology employed in this study aligns with the body of theorists who prescribe *science for all* (see s.2.2.2.1), where constructivist learning perspectives replace the previous discriminatory paradigm where only *elite* students were given challenging subject matter. To meet this challenge, students in the experimental group were engaged in science education with consideration for the diversity of their needs, attitudes, and abilities, or as Gray and Sharp (2001) suggest that "the more children can identify and are engaged with a task, the more effort they will put into it and, therefore, the greater their success rate is likely to be" (p. 87). Another possibility for student outcomes is that teachers in this study used performance assessment formatively. They provided students with information in different ways such as making comments on student's work or within conducting an experiment, and students used this information as feedback to improve their learning.

Finding that performance-based assessment supports low achievers obtained in this study project parallel and confirm the empirical findings of Gray and Sharp (2001a). Gray and Sharp also studied grade 6 science students in an assessment context, comparing the results of traditional and performance-based assessment and found students, particularly lower achievers, perform better on interactive performance assessment than on comparable tasks presented in a purely pencil and paper format.

However, the positive results of this study reflected in students' outcomes in science do not focus on performance assessment as a test method, that is, students merely practising science for later examination. Instead these results encompass a holistic approach to learning, based on the theoretical framework of performance assessment, which is different from the traditional approach of assessing and teaching science. The approach contains interactive factors in learning, teaching and assessing, based on constructivist learning theories, as has been described in the theoretical framework (in Chapter 2) and formulated in the study project (see Figures 5-1, 2). In this approach, performance-based assessment required the learners to adopt higher order thinking, engage in inquiry and problem-solving for a period of time, and the vitalisation of teaching methods that encourage active participation. These activities occur within a social constructivist learning environment where students are able to work cooperatively, and reflect on their work (Roth, 1995; Shepard, 2000b).

However, using performance assessment solely as a separate process from instruction, or within a learning environment based on behaviourist learning principles, focusing on memorisation or recall cannot be an effective assessment method, whether for classroom or accountability use. Accordingly, researchers who used performance-based assessment separately reported no positive effects for performance assessment on students learning science. Shymansky and Chidsey (1997) gave students a one-hour block of time to complete the individual performance tasks to parallel the on-demand nature of the Iowa Test of Educational Development (ITED). They found that students performed poorly on all performance tasks. A similar result, determined using similar performance assessment processes, was found by Huff (1998). He studied the effects of the use of multiple-choice item formats and performance formats for the assessment of learning science at the second grade level (n =16) over two weeks. Both forms of assessment were used after science classes. The results showed no positive effects for performance assessment. However, as he suggested, some disadvantages of performance assessment may be related to the fact that students were not familiar with performance tests. Another possibility is that performance assessments have essential elements, as discussed in Chapter 2, which require drastic changes in teaching styles, curriculum materials, classroom environment, and learning methods.

Another example of research that separated performance-based assessment from instructional procedures was conducted by Century (2002) who also compared the impact of alternative and traditional tests with sixth grade students. Whilst I used in this study different teaching methodologies under traditional assessment and performance-based assessment, Century utilised the same teaching methods for both the control and the applied groups, but they were assessed differently by either performance-based assessment, or a traditional test form. Century's study showed that there was no significant difference between students' performance on the two types of assessment. The lack of clear procedures with Century's work is therefore considered in light of the teaching and learning techniques employed in his study, which were similar in both groups, thus hindering the provision of the basic conditions necessary for applying performance assessment.

Nevertheless, research studies that combined performance-based assessment to instructional procedures found encouraging results. For example, Biondi (2001) who combined performance assessment with instructional procedures found that performance-based assessment is a valid, equitable measurement of student progress. Students became more focused in their work, were able to reflect on their learning activities and abilities, and developed a higher level of vocabulary through group conferences and self-assessments. In addition, he found that performance-based assessment provided students with tangible evidence of their work as they analysed their strengths and weaknesses, became more focused on their assignments and were able to apply their knowledge of the material in a creative manner.

The procedures for implementation of performance assessment as shown in the previous studies have essential impact on the expectation outcomes, so addressing these procedures and considering their recommendations assisted the researcher to achieve positive results for the performance assessment approach. For instance, after an expected result, Shymansky et al.(1997) highlight two important issues for producing a valid performance assessment in science classroom. These are the development of teaching practices and alignment of goals, teaching, learning and assessment processes.

7.1.2 Students attitudes' toward science

The results of quantitative data analyses were that student attitudes toward science have increased significantly for the experimental group, compared to the control group, as measured by the Student Attitude toward Science Survey (SATSS). The resultant small effect size suggests students' attitudes are more resistant to change over a short intervention period. The findings of this study support the use of performance-based assessment to enhance students' attitudes toward science. This result is inconsistent with the findings of Century (2002), who investigated the impact of alternative and traditional assessment on students' attitudes, and science learning outcomes. Century found no significant difference between alternative and traditional groups in their attitudes toward science, and in their science outcomes. This inconsistency may be related to the issue of separating performance assessment from teaching and learning procedures. This separation prevents students from being actively engaged in science class, using both science processes and critical thinking skills as they search for answers (Gibson & Chase, 2002). On the other hand the current result is consistent with the findings of studies that had an influence on students' engagement in science. Using a sample of 699 students from 27 high schools science classes, Myers and Fouts (1992) found that the most positive attitudes were related to a high level of involvement, very high level of personal support, strong positive relationships with classmates, and the use of a diversity of teaching strategies and innovation learning activities. In a similar study, Siegel and Ranney (2003) used activity-based science curriculum focused on connecting science to students' lives. The curriculum concerned scientific evidence to make decisions involving social consequences and their findings were that students' attitudes toward science were enhanced. Similarly, Gibson and Chase (2002) conducted an inquiry-based science program, as a form of constructivism similar to performance-based assessment, to stimulate greater interest in science, and scientific careers within middle-school students. They found that students maintained a more positive attitude towards science and a high interest in science careers. Bilgin (2006) conducted intervention on grade 8 students that included hands-on science activities using a cooperative learning approach. The researcher found that the experimental group had better performance on the attitude scale toward science and on the science post-test.

This consistency between the results of these previous studies and the result of the current study can be attributed to common factors related to classroom variables such as using inquiry, cooperative learning, and linking activity-based science to real life situations.

7.1.3 Performance-based assessment predictability

The results for the third research question which is *Are students' final science examination outcomes predictable through performance-based assessment?* Showed that approximately 23 per cent of the variation in the final science test scores can be predicted by the performance-based assessment scores. This means that the forms of performance assessment such as projects, portfolios and tasks can be used as an accurate indicator of students' progress, particularly in the new Saudi *Continuous Assessment* educational system bylaw, which depends on continuous assessment for promoting students.

However, the method of demonstrating tasks that were designed to assess a student's progress at the end of each unit undermined to some extent the direct correlation between the forms of performance assessment and the final science examination. This is because these tasks should be demonstrated individually to give a valid indicator of students' progress, there was a shortage of experiment instruments, and students performed tasks in groups comparable to other forms of performance assessment. This finding is consistent with the results of Gallant (2005), who concluded that "a curriculum-embedded performance assessment can be used to predict students' performance on a state's criterion-referenced assessment in a later grade" (p. 106).

In this study, although performance-based assessment methodologies were used formatively, and within a cooperative environment, the regression analysis results demonstrate a positive association with the final science test outcomes. A finding of this research is therefore that utilising tools such as tasks, projects, and portfolios for summative purposes has a greater possibility of positive outcomes than the use of traditional tests such as multiple-choice and true or false, particularly with primary school pupils. As performance assessment improves students' learning and attitudes toward science, it could also be considered as valuable for summative assessment.

Traditional testing procedures however can be useful. As proponents of performance assessment, for example, Herman, Aschbacher, and Winters (1992) suggest, using a variety of modes of assessment. A balanced assessment system involving different types of assessment is needed to give a detailed, multi-perspective picture of student accomplishments, that may best serve all functions, knowledge domains, and learners (Haury, 1993; Tillema, 2003a). Nevertheless, Haertel (1999) believes that performance assessment should not be used as external assessment, but just for daily classroom instruction. There is currently however, no external assessment for accountability in the Saudi education system. The scope of this study is to examine the viability of using performance assessment for promoting students to the next class within the new assessment. Thus research finding 3 is that the Saudi *Continuous Assessment* educational bylaw can use forms of performance assessment such as projects, portfolios, and tasks as trusted indicators of students' achievements.

7.1.4 Performance assessment standards

An aim of this study was to develop teachers' assessment standards to implement the study's performance assessment approach. In this study, professional training workshops were undertaken which involved teachers' assessment standards, and essential skills required for implementing the new methods in learning and teaching (see Chapter 3). The result of question four revealed that the mean of teachers performance on the Teacher Performance Assessment Questionnaire increased from 12.17 (SD = 1.72) to 15.5 (SD = 2.88) (power = .49). However, the difference between the two means as tested by paired samples t-test was not significant. This inconclusive result may have been an outcome of the sample size (n=6) rather than a clear representation of the real differences between the performance of teachers in the pre-test and post-test as has been illustrated by the effect size value (1.3). So, in light of the large effect size for the change in teacher performance, this finding is could therefore be considered consistent with the positive results of previous studies (e.g. Borko et al., 1997; O'Leary & Shiel, 1997). This suggests that evidence exists from the qualitative analysis to confirm the findings of previous researchers, that these teachers improved their understanding of performance assessment. In prior research, it has been demonstrated that the most improvement in performance assessment is in the areas such as designing assessment tasks, providing students the opportunity to apply skills, and requiring students to generate information (Morrison et al., 2003).

7.2 Discussion of qualitative findings

The second section in this chapter addresses the qualitative findings obtained from teacher and student interviews conducted at the end of the study project.

7.2.1 Evaluation of implementing performance assessment

Research question five considered teachers' views on trialling performance-based assessment in science class, and their reflections on the new method of assessment, teaching, and learning based on constructivist principles. The participating teachers were asked to evaluate the implementation of the study program in their schools. The teachers' responses, obtained from interviews and analysed by QRS NVivo software, revealed that a positive change in teachers' attitudes occurred as a result of the study intervention. Teachers considered that the original classroom methodology, which was teacher-centric, that is, based on lectures by a teacher and seeking one right answer to each problem, resulted in students generally adopting a passive role as receivers and memorisers of information rather than as active seekers of information. In contrast, the teachers considered that the study's methodology integrating performance assessment with teaching gives students the opportunity to be active, interactive, work cooperatively in groups, and adopt greater responsibility for their learning. In addition, the respondents believed that students master complex skills, for example, conducting experiments and presenting their work in different forms that were not reached by traditional assessment methods.

The teachers in this research reported dissatisfaction with their previous practices in the classroom, and favourable attitudes toward the study methodology of performance assessment are consistent with results of many previous studies. An early study found that teachers' didactic beliefs, initially resistant to conceptual change, underwent conversion during the study to dissatisfaction with prior beliefs. The teachers could identify the intelligibility, plausibility, and fruitfulness of the conceptual change method (Bednarski, 1997; Wozny, 1998).

In this study, the teachers reported disadvantages in applying performance-based assessment including that it was time-consuming, requiring extra work, was difficult to score, and did not suit a class with a large number of students. These disadvantages were a significant challenge in implementing the study project. Time was a constraint in preparing, and implementing performance assessment, particularly as formative assessment with a large class. In addition, using rubrics challenged teachers. At the beginning of the study project, teachers expressed concern about using rubrics to grade students' work. During the course of the project, students' work was initially assessed traditionally, through scoring without any comments available to students. Despite this reluctance, with further training and practice, teachers started to improve their performance slowly. Allocated time however, was insufficient for the application of rubrics in the class in the manner in which they had been trained, particularly with a large number of students. These findings align with those of previous studies, where the time constraints in administering performance assessment methodology to science students also emerged (Shavelson, Baxter, & Pine 1991; Wozny, 1998). However, with more training and practice, teachers can decrease the time required for preparing performance tasks, and adapt the performance task to the time available. Time problems, as reported in similar research projects, are partly due to the lack of accuracy in estimating the anticipated time for students to accomplish a performance assessment task (Borko et al., 1997; McDuffle et al., 2003). This study found that some activities required more time than expected. So, while it is not easy to predict how much time it will take for students to complete a performance assessment task (Borko et al., 1997), the repeated implementation of assessment tasks will help teachers to modify them to meet their individual needs. Embracing educational reform based on constructivist principles could also provide teachers with the necessary time to implement performance assessment.

In addition, the use of rubrics was an obstacle in the implementation of performance-based assessment, and this issue is often raised in the literature related to designing or using rubrics appropriately and formatively (Morrison et al., 2002; Pilcher, 2001). It is suggested therefore that teachers require intensive support and training to master necessary skills for designing and using rubrics (Fuchs et al., 1999; Morrison et al., 2003).

It is clear from the results of this study, as well as from the findings of the literature review, that there are substantial common difficulties facing the implementation of performance-based assessment in the science classroom. These difficulties have been experienced in many national educational environments, with different professional development programs, and among teachers with varying levels of academic qualifications. However, there are factors such as the nature of a national educational system and the support of a particular school environment that contribute to reducing these difficulties to the extent that teachers can successfully implement the widely-regarded benefits of performance assessment. These and other factors, such as scope of the program and attitude of stakeholders to performance assessment, are crucial to the development of teachers' competences over and above traditional pass-or-fail methodologies of teaching-to-the-test.

Unfortunately, the Saudi education system, and the country's primary school environment was considered by this study's participants to be unsuitable for implementing performance-based assessment. The teachers maintained that the educational system in Saudi Arabia, which is based on a traditional teacher-centric system (teachers are the dispensers of information, and students are the receivers), creates a real difficulty in comprehensive reform of science delivery in the country. The issue of a traditional education, as Ebrahim (2004) described, is more concerned with school success, and preparation for the next grade level than with helping students learn how to learn. The teachers mentioned that the length of the science lesson, 45 minutes, was preventing them from applying practices based on constructivist theory. The question that should be raised then is: Is 45 minutes sufficient time to enable a teacher to organise students into groups, and involve them in essential science experiences in which they observe, measure, experiment, interpret, and predict? Is this period of time enough for students to reflect upon their work, or enable a teacher to follow-up on students and provide them with appropriate feedback? This lesson period is more than enough time for the traditional lecture-recitation method where teachers' attitudes are that students' brains are empty vessels waiting to be filled with knowledge imparted by a teacher (Hinrichsen & Jarrett, 1999). The methodology of teaching and assessment that is the focus of this study requires more time with less science content. In fact, it is not just the content of science but also the method of presentation of that content that does not support the application of such innovation in the primary science classroom, as it requires redesign to align with current educational reform waves. This researcher disagrees with the arguments advanced by Al-Abdulkareem (2004) who claims that teachers criticised revised Saudi elementary science textbooks, developed by a team of educators including Al-Abdulkareem, as too short in length (see Chapter 4). The teachers' criticism was based on the textbooks having insufficient content, due to the teacher-centric lecture methodology, whereas the revised educational system uses new teaching methods including problem-solving, discussions, discovery, and inquiry. The disagreement is based on two points, first that there is ample content of traditional Saudi primary school science, and second, quality of learning. On the first point, taking the traditional grade 6 science textbook as an example, each year's primary school science course consists of 13 topic units, delivered by three 45-minute lessons each week. This compares to Singapore, where primary school science has only five topic units for grade six (Singapore Ministry of Education, 2004). On the second point, the learning outcomes inherent in the revised textbooks is questionable if the results or the scientific facts are displayed under the problem on each page, an example of which is presented at Figure 7-1.

What have you learnt?

The same electronic charges repel and the different charges pull toward each other.

Figure 7-1 Displaying scientific facts in grade 6 Saudi science textbook, 2003, p85.

An assumption of this study discussed in s.2.2 is that, based on a constructivist approach, performance assessment should align with curricula. The science curriculum as presented in the revised grade 6 science textbooks discussed above did not meet the criteria for constructivist teaching and learning, thus the targeted science curriculum units for this study were redesigned. Fratt (2002) criticises this type of textbook: stating “science becomes an exercise in memorizing technical terms and getting through the textbook, which may cover dozens of topics. (It is) heavy on vocabulary, and light on actual science… Not surprisingly, these methods have failed to produce science literacy” (pp. 56-57). This researcher, therefore, followed the proposition of Rutherford and Aligren (1990), who suggest that science reform should place an emphasis on the necessary concepts for scientific literacy, and study each area in depth rather than attempting to address too many concepts within the science curricula, thus not addressing any significant depth (Smith, 1997). *Designs for Science Literacy*, a report from Project 2061 of the American Association for the Advancement of Science recommended generating more time for in-depth study by suggesting some strategies such as reducing the number of major topics taught, and reducing the length of some topics by removing unnecessary detail (AAAS, 2001).

Perhaps because the Saudi education system limits teachers’ opportunities to participate in initiatives and develop professionally, the participants unexpectedly enjoyed their work as part of the study project. This result is consistent with results reported by Bednarski (1997), who found that teachers who used performance assessment raised issues about implementation, nevertheless adopted this methodology in their teaching practices noting that the benefits of using performance assessments outweigh the difficulties. Bednarski’s findings, paralleled in this study, are consistent with several studies (Fuchs et al., 1999; Howell et al., 1999; Shepard et al., 1996) in that classroom-based performance assessment enhanced teachers' thinking about their teaching, and professional development.

However, the results from this study may not support the statement that was presented in Chapter 4; Saudi teachers lack the motivation to develop their professional performance. In fact, most participants expressed full cooperation and extended their best efforts to apply the study project. This response can perhaps be attributable to the fact that, in addition to training, these teachers were involved fully in the project. They discussed its theoretical concepts, were encouraged to evaluate its components, and received continuous support during the implementation period. It is understandable that research studies in teacher motivation have mixed outcomes. However, given the response by teachers to this study, it is argued that teachers' attitudes may not be hindering educational reform; the fault, as it were, lies with Saudi educational policy. Strategies discussed in the literature review (Chapter 4), for example, lack of support for teachers in developing curricula and assessment methodologies, excessive supervision, limited opportunity to develop professional development, and implementing new education systems without appropriate training or consideration of workload are issues that widen the gap between stated educational outcomes for students and the current reality in Saudi schools.

7.2.2 Appropriateness of Saudi school for applying performance assessment

The sixth research question asked teachers about the appropriateness of the Saudi school environment for applying performance-based assessment in terms of provision of the necessary materials and supportiveness of the community. All participating teachers reported a shortage of curriculum materials including science books. The teachers also mentioned the inadequacy of science laboratories. This finding supports research on the attitudes of Saudi science teachers to effective schoolroom practices. Aljabber (2004) found in an empirical study that teachers avoided implementing effective methods, such as problem solving, inquiry, demonstration, and cooperative learning, due to several factors including time limitation, lack of learning sources, a large number of students in the classrooms, lack of well-equipped laboratories, and lack of materials and equipment.

There are three factors which may contribute to this situation. First, most teachers use a lecturing style, and so do not need a science laboratory. Second, equipping a science laboratory entails substantial administration and a protracted approval and procurement system. Further, the equipment is then the responsibility of the science teacher, affording further work in maintaining the premises to an adequate standard. Third, Saudi Arabia’s high population growth of 3.3 per cent (WHO, 2005) impacts on the Ministry of Education’s ability to provide appropriate school facilities for the annually increasing numbers of children entering the school system. The Ministry therefore rents residences to provide temporary school premises for young children. The absence of a national plan to absorb this rate of population growth contributes to the worsening situation and therefore the number of rented school buildings exceeds the number of governmental schools. For example, in 2006, there were 320 rented schools and 246 government schools in Riyadh alone (Ministry of Education, 2006). As housing, the rented premises are inappropriate for schooling purposes, lacking dedicated and well-equipped classrooms, safety requirements, laboratories, and libraries (Al-Otaibi, 2005; Almegidi, 2004). Aljabber (2004) considers that there is a better learning environment in governmental school buildings as they are well-designed in terms of size of classroom, laboratories, libraries, and learning sources, factors typically lacking in residential housing. In this study, two of the six participant schools had suitable science laboratories. Two of the schools were rented and only had small unequipped laboratories, whereas one rented school had no laboratory at all. However, I did provide teachers with the specific equipment, and materials necessary to conduct the study project.

In regard to the research evidence relating to support from the school community, the majority of responding teachers had little knowledge about the role of school staff, particularly principals and peer group teachers, in implementing performance assessment in their schools. In Saudi Arabia, education policy does not support cooperative work or a collegiate atmosphere where experiences are shared among teachers. Darling-Hammond and McLaughlin (1995) assert that new approaches to the professional education of teachers require continuous support. These approaches cannot promote meaningful or long-term change in teachers' practices, if they are embedded in an environment where teacher professional development support does not exist. Several studies give school principals a great role in developing teachers' performance (Brewster & Railsback, 2003; McEvoy, 1987; Watkins, 2005). Conversely, as observed, most principals of participating schools were not enthusiastic about their teachers' involvement in professional development programs, and teachers were prevented from participating in the study project. In the same manner, Shepard (1995) found that "not all ...teachers in the project were true volunteers. Some had been implicitly volunteered by their principals" (p. 39). A further observation leading from the discussion on teacher professional development in Chapter 3, is the unwillingness of principals in this regard may be attributable to the Saudi educational system which does not connect the principals' performance to students' outcomes, but to school management. Al-Madhi (2003) has this concern:

> School principals in Saudi Arabia currently do not have the qualifications or experience to supervise teachers. Generally, Saudi principals are selected without clear performance standards to ensure their success in this regard. Thus, some graduates from colleges that do not provide educational training are selected to be principals (p. 7).

7.2.3 Students' impressions of performance assessment

The seventh research question examined students' impressions of the main components and strategies of the study project, and whether or not they would like to continue studying science using the new method. The interviews began with this researcher asking students to identify the main differences between the old and the new methods in studying science. Students were able to distinguish between the two methods, and to describe the main features of each one. They described the old method as a teacher-centred method in which a teacher explains a lesson, asks students to copy down the lesson from notations on the whiteboard, and focuses on the use of the science textbook. Students reported, they listened to their teacher and wrote lessons or read books as instructed. This description by participating students is similar to that given by Ebrahim (2004), who studied the effects of two teaching methods on science classes in Kuwait primary schools:

> A typical approach of most traditional science lessons, which rely on teacher-centered methods, consists of lectures, readings, questions and students' answers. These approaches are often limited to information provided by the adopted textbook and assume that students should mainly pay attention to the teacher (p. 21).

The participating students' responses to the new method in this study project were that they focused on *understanding* as the primary outcome of their endeavours in the science class. The students were given the opportunity to work differently, using activities involving experimentation, conducting projects or solving problems, and encouraging reflection on their work. These allowed them to fully use their abilities, and enhance their skills. These were in contrast to the students' previous study methods of memorising facts, the prominent goal of traditional assessment. Fostering students' understanding was- and still is- the main purpose of many of the educational reform movements (Slavin, Madden, Karweit, Livermon, & Dolan, 2001).

When asked about the elements of the new method, students found components of performance assessment such as rubrics, and self-assessments useful, and helpful in improving their performance. Although a rubric was basically designed for teachers to assess students' work, it was used, as Andrade (2000, 2005) suggests, to be an instructional rubric for students to assess their work against standards. According to Arter (1993)

> The development of good performance criteria is not just an exercise in developing an assessment tool that is external to the instructional process ... Good performance criteria

> help teachers and students understand the target of instruction: what is expected? What does good look like? And what do I want to accomplish? (p. 4).

Following on, and extending upon the work of Andrade (2000, 2005) and Arter (1993), students in each activity of this project, were given a rubric at the beginning of an activity as a standard to attain. Students appeared to use the rubric criteria differently; some students using the rubric to improve their performance and as a benchmark, whereas others ignored the criteria before undertaking the task. These differential uses for the rubric may be attributed to inadequate training by the teachers in the use of the rubric, or simply that the student chose to disregard it. Again, this result is consistent with Andrade's (2005) finding that some students anguished over the best use of a rubric and others forgot about it. The researcher concludes that rubrics are not entirely self-explanatory and that students need help in understanding and using them.

Participating students' responses showed positive effects of self-assessment on students' motivation and performance. After learning science under performance assessment, students had greater confidence in their ability to assess themselves, and to control their learning. This finding is consistent with the key theoretical principles of self-assessment presented in the literature review (Andrade, 1999; Peatling, 2000; Trotman, 1998) as well as the findings of empirical studies (Olina & Sullivan, 2002). For example, Alabdelwahab (2002) examined the introduction of a self-assessment portfolio in an English class at a Saudi intermediate school. The researcher reported that students found the process of reflecting on one's learning to be helpful in identifying strengths and weaknesses in their learning. Similar to

Alabdelwahab's findings, this study evaluated cultural factors not considered in the majority of studies relating to students' self-assessment. The first factor is the nature of the relationship between a Saudi teacher and their students. Some findings here are consistent with Peatling's (2000) assumption that self-assessment will enhance relationships between teachers and students, while other findings show that when a student assesses his or her work accurately, and identifies the weakness in learning, these may have an adverse effect on the teacher who believes that assessment is the teacher's role. This belief among students may be related to implicit beliefs in the Saudi teacher-centred methodology. Saudi teachers have responsibility for their students' learning, thus they have an active role, and students passively absorb the teacher's lessons. If a student misunderstands a fact in this classroom environment, it directly impacts on the teacher as failing to properly impart a lesson to the students. Another interpretation is provided by Alabdelwahab (2002):

> Sensitivity to one's teachers' viewpoints is greatly valued in the Saudi Arabian culture. In Saudi Arabia, students tend to respect teachers and try to win their confidence; since this may influence the grades they assign in the future (p. 133).

Student embarrassment is a possible factor in this discussion. Many students do not like to expose their weaknesses to their peers. This concern was raised as a cultural element in Alabdelwahab's study where it was interpreted as "the refusal to expose one's weaknesses to others (which) is typical among Bedouin tribes in Saudi Arabia" (p. 134). This researcher disagrees with Alabdelwahab's interpretation on the basis that defensive behaviour of this nature is common in Arabic society, and is reflected in many cultural aspects, poetry and novels.

The students preferred using a portfolio, a folder to hold their work and encourage reflection on past achievements. However, they had different views on the importance of portfolios; some students perceived the portfolio as a means of storing their work, or to aid reflection on their work, whereas, others thought of a portfolio as a useful tool for including parents in student assessments. These perspectives are consistent with previous studies. Brooks (1999) found that students had different perceptions of the portfolio. Considering portfolios as a reflection tool aligns with assumptions that the most effective usage for portfolios is to help students to recognise the strengths, and weaknesses in their development (Hall & Hewitt-Gervais, 2000; Shepard, 2000b). Tillema (2001) investigated the effectiveness of three types of portfolios: the dossier portfolio, the course-related learning portfolio, and the reflective portfolio. The result shows that the reflective portfolio is an especially effective assessment tool for bringing about performance, and learning-related change. Although portfolios were used to track students' accomplishments, as discussed in s5.3.1, the participants in this study did not perceive the role of portfolios as an assessment tool. This view is attributed to the period of implementation, about two months, which did not allow sufficient time to show students the process of using their collected work to assess their progress.

Regarding the projects that students conducted, the study findings show that students enjoyed conducting projects for different reasons, such as being allowed to work in the area they like, and working in depth on a particular topic. This finding is consistent with research conducted by Pfeifer (2002), where students reported that the projects allowed them to be actively involved in a topic, to learn about topics in depth, and to find information about topics beyond the textbook.

When students were asked what they liked most about the study program, they mentioned experiments conducted in an open class environment, and working in groups. These preferences may reflect the manner in which students conducted the experiments, through inquiry and problem-solving. Students' activities were based on concrete materials and their own experiences, thus engaging students in the context of the activity. The teaching style, that is, giving students the opportunity to act freely with less control, encouraged students to take risks, and be involved in challenging tasks. In a study of restructured schools (less departmentalisation, more heterogeneous grouping, more team teaching, and a composite restructuring index) Lee and Smith (1993) found positive gains in the academic achievement, and engagement with academic work among the students.

All students highly valued working cooperatively in groups, helping each other to understand their material, and encouraging lower achievers to participate with their peers. This finding is consistent with Johnson and Johnson (1993a; 1993b; 1999), who reported that students who discuss subject materials with peers learn more effectively. Bilgin (2006) found that in the cooperative learning approach students are in an active role, they are able to work in groups, and develop social interactions. In addition, Stanne, Johnson, and Johnson (1999) found that cooperation promotes significantly high motor performance. Likewise, Hwang, Lui, and Tong (2005) found that students who were taught using a cooperative learning approach significantly outperformed those who were taught using a traditional lecture format.

The last question students were asked was whether they would like to continue studying science with the new method. Not surprisingly, the replies were that they wished to continue using the new method. This result is consistent with Herman et al. (1997), who found that students find alternative assessment more interesting and challenging than traditional tests. Similarly, the result reported by Biondi (2001) shows most students were in favour of performance assessment.

The important point in the students' responses is that the cognitive and behavioural engagement of students in learning science by the new method has positive effects on their dispositions and personal identity. This engagement involves reflecting on, evaluating, discussing, and organising their work using different forms and strategies. Particularly, students indicated that they were highly motivated when they felt they were able to control and manage their own learning. Consequently, they felt less dependent on their teachers and were encouraged to learn more about science. According to Linnenbrink and Pintrich (2002) "the more important motivational beliefs for student achievement is self-efficacy, which concerns beliefs about capabilities to do task or activity" (p. 315). It is positively related to higher levels of achievement and learning as well as a wide variety of adaptive academic outcomes, such as higher levels of effort, and increased persistence in difficult tasks (Linnenbrink & Pintrich, 2002). Based on Bandura's social cognitive model, self-efficacy is situated, and contextually affected, by actual experience that refers to past experience, within which success experiences increase self-efficacy, and failures decrease it (Bandura, 1986). In their framework for self-efficacy, Linnenbrink and Pintrich (2003) related efficacy to student behavioural, cognitive and motivation engagement. The researchers assume that engagement, leading to superior learning ability and thus performance, promotes self-efficacy. This assumption supports Hsu (2001) finding that students who had high self-efficacy toward performance standards had effective outcomes in performance assessment. It is also consistent with results reported by Linnenbrink and Pintrich (2002). They noted that student's self-efficacy beliefs are positively related to student cognitive engagement and their use of self-regulatory strategies, as well as general achievement as indexed by grades.

7.3 Summary of discussion

The study findings support the prior literature that view integrating performance-based assessment with curriculum and instruction is a vital element for educational reform. The findings are also consistent with previous studies that suggest performance assessment to improve students understanding of science. On the other hand, the study reached the similar results of the literature review that substantial common difficulties have been experienced in many educational environments, facing the implementation of performance assessment in the science classroom. In addition to these common difficulties, the findings of this study revealed that the current Saudi educational system and environment create substantial barriers to implement such reform based in constructivist learning theory and to apply new methods of assessment and teaching that requires students to demonstrate higher-level thinking skills and to encourage them to be self-learners.

CHAPTER 8: SUMMARY AND RECOMMEDATIONS

The previous chapter presents an in-depth discussion of the findings of this thesis. It encapsulates the purpose of this study, which is to develop a performance assessment approach based on constructivist learning concepts, with learning and instruction content focusing on inquiry and problem-solving in the cooperative science classroom. An objective is to examine the effects of this study's approach compared to traditional testing methodologies in the assessment of students' learning in grade 6 science classes in Saudi primary schools. Research findings and conclusions on these themes are then discussed, identifying important methodologies and recommendations which build the central thesis, to develop a performance assessment approach based on constructivist learning concepts. The thesis then explores the study project's methodology, the Saudi environment in which it takes place, the project itself , and its findings and outcomes. Since performance-based assessment occurs over a period, it provides an opportunity for students to individually achieve the highest level of learning (Baker, 1996). Unlike the memory-based traditional testing procedures, performance-based assessment is authentic assessment, because it involves the performance of tasks that are valued in their own right, it is situated in a real world context, and it can mirror actual tasks implemented by scientists (Jorgensen, 1994; Linn et al., 1991; Mabry, 1999). These characteristics of performance-based assessment allow students to engage with meaningful problems that serve significant educational experiences (Garbus, 2000; Kulieke et al., 1990; Linn, Baker, & Dunber, 1991).

Chapter 8 includes a summary of the study, a general discussion, conclusion and implementation

8.1 Summary

The purpose of this study is to develop a performance assessment approach for classroom implementation, and investigate its effects on sixth grade students' science achievements, and attitudes toward science. An objective is to investigate the capability of Saudi primary schools to successfully adopt the developed approach of the study project in terms of facilities, consumables, and community support. Although the Saudi educational system has witnessed substantial development in the last half-century, student assessment methodologies remain a low priority and educational reform in that regard tends to lack depth and commitment.

A brief historical perspective of science curriculum reform in relation to assessment practices over the last 60 years is presented in Chapter 2. The early science curriculum reforms neglected to make necessary the development of the assessment methods in alignment with new concepts, such as process skills. Consequently, a test-driven curriculum has been raised as a mean for educational reforms. The simplified concept of teaching-to-the-test as a basis for teaching and learning had excessive influence on learning and teaching science (Kane et al., 1997), limiting learning to basic skills, and compartmentalising science in particular into a question and answer format. Moreover, it has a negative effect on students, teachers, and the quality of curriculum (Noble & Smith, 1994). Over time, therefore, educators have shifted from assessment by testing toward alternative assessment, namely performance-based assessment, as theoretical and empirical research began to drive reform. There is mounting evidence that alternative assessment can have a positive effect on instruction and curricula (Moon, Callahan, Brighton, & Tomlinson, 2002).

There are now several models of alternative assessment forms for science curricula. However, both curriculum and assessment reforms have a common factor; they are based on cognitive and constructivist principles. This link has been clarified in a framework developed by Shepard (2000a; 2000b), and I further developed the framework for science subjects.

The framework presented in this thesis is composed of three dimensions (see s.2.2), and under each, a number of principles are discussed. In the cognitive and constructivist learning theories dimension, several principles are presented and shown to have an impact on science curriculum and assessment reforms. Based on the theoretical framework, the study project was designed to cover two units of Saudi grade 6 science curricula. To implement the study project, 12 science classes comprising 289 students from six primary schools in Riyadh were selected, and divided at random into experimental and control groups. Prior to implementing the study project, science teachers were trained for two weeks to participate in the study intervention. A pilot study to test the curriculum instruments was also part of the study project. The study's design included pre-test and post-tests respectively for the students' final science test, a survey on attitudes toward science for students, and the teachers' Performance Assessment Questionnaire. The study project incorporated a range of performance-assessment tools for implementation in the classroom; and the practical section of the study concluded with interviews for all teachers and 12 students.

This study employed two distinct but complementary data analysis methods to produce an optimal analysis of comprehensive science education reform in the primary science classroom; and for instruction, learning and assessment. A quantitative method was used to analyse the first four questions and a qualitative method for questions 5 to 7.

The findings of the quantitative analyses show that there is a significant difference between the experimental and control groups in the means of their scores in the final science exam, as calculated by independent sample t test, $t(263) = 9.30$, $p = .003 < .01$. Also, there is a statistically significant difference between the attitudes of the experimental and control groups toward science, as examined by ANOVA, $F(1,223) = 6.08$, $p = .014 < .05$. The result of linear regression shows that performance-based assessment can predict 23 per cent of the variation in the final science test scores. However, the findings also indicate that there was no significant difference in the performance assessment competences of the science teachers as measured by the Teacher Performance Assessment Questionnaire (TPAQ), between pre-test and post-test.

The findings of the qualitative analyses reveal that the main trend determined from comparing the new and the old methods of assessment is favourable toward the new method. Teachers report that the traditional method whereby a teacher transmits information to students in a controlled class in which students are limited in the development of their abilities, was teacher-centred rather than student-centred. Using the performance assessment methodology of the study project, they reported that students become involved with their own learning when they are offered the opportunity to be more active during class. Teachers mentioned several advantages, and disadvantages with the new method. They reported that students in the experimental groups were more active, interactive, worked cooperatively in groups, and became responsible for their own learning. In addition, the reform methodology of performance assessment encouraged students, and their teachers, to use critical thinking skills. Moreover, students who were traditionally low achievers were encouraged to fully participate with their groups.

On the other hand, the disadvantages mentioned by teachers were that the new method is time consuming, requires extra effort, is difficult to correct ,and does not suit a large class. Study participants stated that these difficulties were compounded by the schools' environment, school day duties, time limitations, and the lack of resources and facilities.

However, teachers enjoyed participating in the study project because of the reported benefits for both teachers and students. The participant teachers reported noticeable professional development for themselves as a result of participating in the study project in science classrooms, in terms of formulating open-ended questions, running group work, designing experiments, and using assessment formatively. Also, they indicated that the participating students responded well, enjoyed hands-on science classes, and benefited from the study.

Teachers found that the participating primary schools had a general shortage of science materials, as well as science books. The majority also reported that laboratories are inappropriate, compounding the difficulties those teachers already faced. In terms of the role of the school community in reform studies, teachers did not recognise a particular role for school staff members, particularly principals and other teachers.

In a view that was consistent with that of their teachers, students perceived the old method as a teacher-centered method, in which the students' role was limited to listening to the teacher, and doing what they were told, usually reading or writing. They viewed the study project's methodology as student-centred, which gave them the opportunity to be active participants in the science class. To highlight their opinion regarding the old and the new direction, students mention that under the traditional class work, a science textbook was the main resource for learning, and the teacher asked them to read it and answer questions about its content at the end of each unit. The problem with this traditional method, students asserted, is that they realised after the study, they could not understand science properly from reading the science book, or writing answers. In contrast to their previous lessons, students found in the new method opportunity to participate actively in the science class, and learn by themselves. Students also found that the method of performing activities or experiments based on group work encouraged them to work cooperatively, and help each other to understand, rather than working individually as before. However, students reacted differently to rubrics, ranging from those who used the tool for self-assessment and improved outcomes, to those who dismissed the offer. The student participants approved of the use of a portfolio in science class for different purposes, including referral and reflection on previous work, and a good place to store papers. Conducting projects also received positive responses, especially performing experiments, and working cooperatively in groups. All students reported they wished to continue using the new learning method in their science class, however, they mentioned different reasons, relating to cognitive and personal aspects that supported in general self-efficacy development.

8.2 Conclusions

This study concludes that the integration of performance-based assessment with instruction and curriculum in science classroom can have a positive effect on students' achievements and attitudes toward science. Students realised that working cooperatively in groups under a strategy that applies different types of performance-based assessment to inquiry and problem solving methods gave them the opportunity to be active participants in the science classroom and learn by themselves. Their responses showed that by offering different forms of performance assessment, the students could use their capabilities and potential for higher thinking, rather than relying solely on memorisation for future tests. Consequently, this form of assessment enhances students' understanding of science, and develops personal and social skills which in turn improves an individual's self- image. Performance assessment is an opportunity for students not just to develop creativity and display more of what they know, but also to foster a more positive attitude toward science.

Despite inconclusive quantitative outcomes for teachers' assessment standards, because of the size of the sample, their responses in the qualitative assessment showed marked improvement in their teaching and assessment practices, and revealed their enthusiasm to develop their professional performance. However, unless profound change occurs, Saudi primary schools are unable to implement a comprehensive science class reform based on constructivist learning perspectives as described in this study.

There is a shortage in both the necessary equipment for science labs and science resources which prevents students from learning science as a practical subject that requires students to make experiments and conduct investigations. In addition, the ample content of the science curriculum with limited teaching time available per week, and extensive teacher workload burdens, has limited the opportunities for teachers to teach science in depth, instead of covering many topics in a short time.

8.3 Recommendations

The overview of practice and procedures detailed within Chapter 4 indicate that despite the obstacles that facing educational development, educational reform is a priority for the Saudi Ministry of Education. There is a national commitment for improving the educational system which is supported by the provision of a considerable annual budget as shown in Chapter 4. Most recently, the Saudi government announced the King Abdullah Project for the Development of Public Education. The project which costs 9 billion Saudi Real (about $AU 3 billion) includes upgrading curricula, improving the education atmosphere and professional development training for inservice teacher over the next six years (Abdul Ghafour, 2007). Therefore, the recommendations that can be drawn in light of the current findings are expected to be seriously considered within the current efforts of the education reform.

8.3.1 Recommendations to the Ministry of Education

1. The development of assessment practices in primary schools should be considered as a part of a whole educational reform that encompasses curriculum and teaching style. This study provides a model of integrating performance-based assessment with curriculum and instruction in primary science[4]. It consists of materials, based on theoretical framework that can be adapted for developing science education in Saudi primary schools and be used with a large group within different experimental stages.

2. Based on this model, a long-term professional development program should be launched at the national and district levels to foster familiarity and competency in classroom assessment for teachers, focusing on performance-assessment forms, and allocating sufficient resources to provide them with the opportunity to learn and grow professionally.

[4] See Appendix I.

3. Developing science curricula requires setting standards involving essential learning elements, and providing students with life learning skills. The curriculum must be intellectually rich and sufficiently broad to address students' developmental needs in all domains.
4. Based on the view that science is a key subject in school education, sufficient time in the school schedule should be provided for science with consideration of science laboratories and tools as main components of a science education.
5. The procurement system for furnishing primary schools with the requisite equipment and consumables for science laboratories needs urgent change. Schools must be provided with science class materials at the beginning of each academic year, when student numbers can be assessed. Also, laboratories should be continuously evaluated in regards to equipment and safety procedures.
6. Prepare teachers, parents and the community for such reform in developing assessment and science curricula, and engage them as participants in all stages, in order that they view these goals and plans as their own.
7. To improve schools' performances, principals should be selected competitively according to objective standards, and evaluated in light of students' achievements and teachers' development. They should be

professionally qualified as educators and administrators, capable of achieving a culture of development in the school environment.

8. School premises should conform to international standards for facilities, equipment and consumables to meet students' psychological and knowledge requirements. The gap in the quality between rented and governmental schools needs to be removed to ensure that students have equal access to quality educational services.

9. Class sizes and student-teacher ratios should conform to best practice international standards.

10. When a specific educational initiative is being implemented in schools, it should be supplemented by teacher training programs, thereby involving them in the initiative's processes. A prime motivation for teachers is to participate in, and implement initiatives, with on-going support and continued evaluation.

11. A culture of development and innovation should be established and encouraged in the schools environment, to allow teachers to work cooperatively, and transfer successful experience from skilled teachers to others.

12. Under the central system, the Ministry of Education is finding difficulty in providing all levels of education, from structure to acquiring schools. Consideration of a division of responsibility would usefully limit the Ministry's role to legislation and

accountability roles. It could then focus on establishing systems and standards for the Saudi educational system and monitor its functions. Educational districts could manage the operational aspects of implementation and development of established performance standards, thus allowing for region-specific variations.

8.3.2 Recommendations to primary science teachers

1. Emphasise the implementation of performance assessment as a means of increasing levels of student achievement. The integration of performance-based assessment with instruction and curriculum provides opportunities for students to learn, understand, and apply science by allowing them to examine, represent, transform, solve problems, and communicate about science on a regular basis.

2. Teachers should change their roles to be curriculum and assessment designers, taking into account the diversity of students' needs and to be classroom facilitators, and guide students by supporting them during their classroom practice.

3. Teachers should use the group work techniques as much as possible to allow students to work cooperatively and place an emphasis on communication and social skills.

4. Students should be given the opportunity to be active learners, who seek knowledge by themselves, are able to assess their performance, and are given advice as they need it.

5. Portfolios are a multi-function tool that can be used for assessment as well as for learning, so students should be trained to use them in positive ways, not just for storing their work.

6. Since science textbooks provide limited opportunities to take into account students' individual differences, project work allows flexibility to incorporate those differences without affecting the teaching plan, which assumes an end in a specific period. Indeed, they enhance students' creativity and create a direct link between science topics and real life situations.

7. According to the findings of this study, students preferred performing experiments and working in groups. These require adaptation and insertion into lesson plans, using appropriate techniques for each class.

8.3.3 Recommendations to education districts and primary schools

1. Teachers should be allowed to have a chance to practice new assessment and teaching methods and be encouraged to be creative, to design and use performance-based assessment as a main part of their classroom practices. These are accessible through ongoing workshops and appropriate professional programs that aim first to change teachers' perspective, showing them the benefits of developing their professional performance, and then training them to master specific skills.

2. Current school structures and schedules include little time for in-school collaboration, inquiry, and discourse. Professional development

should be considered an on-going part of school life, therefore, time and resources should be devoted to professional development.

8.3.4 Recommendations for future research

Because of the lack of supporting studies available in Saudi Arabia related to science classroom assessment, further research would have to be done to provide more insight into the primary science educational reform. The following studies are recommended:

1. A similar study could be conducted for one year with science or other subject areas that allows teachers to participate in designing the study's components.

2. Although this study gives indicators of the effectiveness of several factors, further research should focus on the examination of the effectiveness of a particular factor such as self-assessment, project, portfolios, problem-solving method, or cooperative learning.

3. The present study could be repeated in girls' schools.

4. It may be useful to conduct a study to track the historical development of educational assessment in Saudi Arabia, linking it to the educational programs offered by teacher training colleges.

5. The development of teachers' assessment standards can be investigated by using a larger sample and link that to other school factors to identify the variables that prevent or support professional development.

6. It may be useful to address in further depth whether or not the current science curriculum aligns with the application of performance assessment and teaching methods.

7. Study the effects of performance-based assessment on particular cognitive and personal factors, such as critical thinking, self-concept, self-efficacy and responsibility.

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Appendix A
Performance Assessment Program
Part (1)

Units of Work

This appendix involves samples of the main components of the units of work of Science Units 9 and 10, designed for Grade 6 in Saudi primary schools.

Essential Learning

Science subjects offer many opportunities for incorporating essential learning into instruction. The purpose is not just to help students to learn and understand subject matter but also to prepare each student to survive and thrive in today's rapidly changing society. However, the decision to focus on one or more essential learning elements within a lesson is guided by the nature of each unit of study and the needs and abilities of each student in the class.

There is no single best way to choose essential learning elements which would be acceptable to all teachers. This means, in the first place that the choice is affected by teachers' perspectives, and in the second place that many elements may be linked with more than one lesson. So, as you develop learning and teaching sequences, you should focus on the 'big picture' description of the essentials and to also work 'backwards' from these to identify the 'big ideas' as the starting point for your planning. Therefore, in each activity, you will find a rubric that focuses on a few elements of essential learning, aimed to help you to concentrate your observation on particular elements without ignoring the rest of the elements that you plan to achieve by the end of the unit or semester.

Knowledge & Thinking skills Using science process of inquiry and critical thinking to develop an understanding of science and particular habits of mind, to create and generate solutions.	Performance indicators involved: • Using inquiry strategies and processes such as ▪ Generating questions that can be answered through scientific investigation. ▪ Using a mind map to plan inquiry processes and strategies to collect and record information. ▪ Identifying information relevant to their inquiry in provided sources. • Using some critical thinking skills such as: ▪ Knowledge: Recall of data. ▪ Comprehension: Understand the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words. ▪ Application: Use a concept in a new situation or unprompted use of an abstraction. Apply what was learned in the classroom into novel situations in the workplace. ▪ Analysis: Separate material or concepts into component parts so that its organizational structure may be understood. Distinguish between facts and inferences. ▪ Synthesis: Build a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.
Communication skills Having the ability to make effective use of language, mathematical information and the tools of information by participating in, and communicating about, diverse scientific issues	• Work cooperatively as a member of a group. • Communicate clearly to a range of audiences for different purposes. • Work to improve relationships with others. • Comprehend important ideas and details. • Listen and observe to gain and interpret information. • Use different forms of communication with a community. • Share information and knowledge with others.
Values & attitudes Developing a sound moral character, a sense of community, and competence in responding to the personal, social and cultural aspects of life	• Accept increasing levels of responsibility for own learning. • Demonstrate responsibility to self and others. • Be intellectually honest and rigorous, showing commitment to scientific reasoning and striving for objectivity. • Develop interest and enthusiasm toward exploring and investigating properties of science. • Recognize the importance of guidelines for experimentation. • Develop an awareness of the importance of science in our lives.

	• Develop an interest in and enthusiasm for investigating scientific phenomena. • Value scientific information that has been collected and verified over time. • Demonstrate a sense of curiosity about science. • Voluntarily read and look at books and other materials about science. • Maintain an open and questioning mind toward new ideas and alternative points of view. • Seek and weigh evidence before drawing conclusions.

COOPERATIVE LEARNING
CLASSROOM MANAGEMENT TECHNIQUES

Office of Science & Math Education. (n.d., pp. 16-17). *GET A CHARGE*: Teacher's Guide: Illinois State Board of Education, from www.sciencemadesimple.com

1. In order for your students to complete the activities successfully, it is essential that they know, and follow, the ten rules for group work:
   * Move into groups quietly, without bothering others
   * Use quiet voices
   * Stay with your group
   * Everyone does a job
   * Everyone shares the work
   * No one is bossy
   * Everyone shares materials
   * Everyone shares ideas
   * Take turns talking
   * Care about others' feelings

2. Initially avoid competition between groups. This can be accomplished by carefully selecting groups in a variety of manners--randomly (i.e. by birthdays), by students' abilities, or by allowing the students to choose groups for themselves. It is important to note, however, that if the final technique is used to form groups, the students must be made aware that if their group does not perform adequately or productively, alternative selection methods will be employed (i.e. teacher selection)!!
3. Clearly define the task to be done.
4. Be sure there is a "product" connected with the group activity.
5. In setting time limits, allow too little time rather than too much time for the group to finish.
6. Each person in the team should play an active role. Regular rotation of roles should occur to give each student the opportunity to play a different role. Roles students can have are:

PRINCIPAL INVESTIGATOR	This person keeps the group members on task, makes sure the activity is understood by all and is completed. Any questions will be immediately clarified with the teacher
MATERIALS MANAGER	This person obtains all supplies the group needs. If the group is large enough, a second Materials Manager can be assigned to be responsible for returning materials to the supply area and having the group clean up its work area.
RECORDER/ EVALUATOR	This person writes down responses that team members have formulated. This person notes how well group members perform their responsibilities, contributing to the overall performance and outcome of the group.
REPORTER	This person writes down the group's conclusions and reports to the class. The reporter may also need to record the

group's data on a class graph or chart. If the group is large enough, two Reporters can be assigned--one to record conclusions and chart data, the other to present their findings to the class.

7. Follow the Five C's of Group work in order to have a safe, and FUN, science activity:

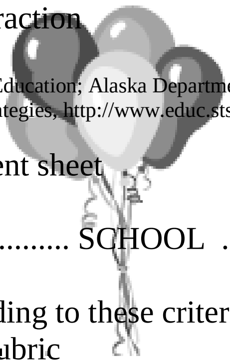
CAUTION	Laboratory group work requires caution in every part. Safety instructions should be followed and a safety checklist should be implemented before each activity.
COOPERATE	To insure successful group work, each member must cooperate with the other members of the group.
CONTRIBUTE	Each member must make an effort to contribute something to the group.
CONTROL	Group work requires control over our body movements, voices and actions. To avoid chaos in the classroom, control must be practiced by each member of the group.
CLEAN-UP	Each group member must do his or her part to clean up after the activity. Students must make sure the work area is clean and all materials are put away.

8. The culmination of a group activity should be a time of sharing and evaluating how well group members worked together as well as examining the groups' end results or products.

Unit 9: Electricity

No.	Learning Outcome
1	Students will be able to : Demonstrate that objects can be charged by friction
2	Demonstrate that unlike charges attract and like charges repel.
3	Identify the two major sources of electrical energy, and provide examples of each. Include: chemical sources such as batteries and solar sources.
4	Identify contents of a battery.
5	Draw diagram of a simple circuit.
6	Construct a closed circuit by making a bulb light.
7	Experiment to classify a variety of materials as insulators or conductors
8	Create a simple switch by using basic materials.
9	Demonstrate and describe the function of switches in electrical circuits
10	Explore to determine factors that affect bulb brightness in simple series and parallel circuits.
11	Draw diagram of simple series and parallel circuits.
12	Use appropriate vocabulary related to their investigations of electricity
13	List electrical devices used at home, at school, and in the community, and identify the human needs that they fulfil.
14	Explore motors and generators to determine that electromagnets transform electricity into motion, and motion into electricity

Electricity
Activity 1
Attraction



Adapted from: Peters & Gega (2002), Science in Elementary Education; Alaska Department of Education & Early Development, A collection of Assessment Strategies, http://www.educ.stste.ak.us.

Student sheet

NAME:.. SCHOOL ....

Your teacher will assess your work according to these criteria

Rubric

Excellent	Good	Satisfactory	Needs Improvement
Used observation to understand the attraction process between two subjects. Answered all questions correctly. Provided appropriate illustration for what was observed. Demonstrated in-depth understanding of the concept of static electricity.	Used observation to understand the attraction process between two subjects. Answered most questions. Provided illustration for what was observed. Demonstrated understanding of the concept of static electricity.	Used observation to understand the attraction process between two subjects. Answered some questions. Provided some relevant illustration for what was observed. Showed a little understanding of the concept of static electricity.	Answers may be totally incorrect or irrelevant. Blank/no response

Teacher Comments

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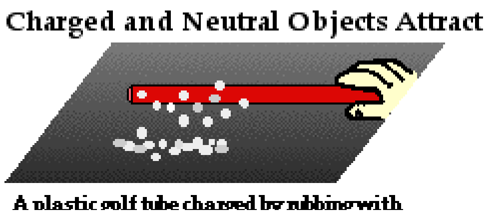
Invitation

Something strange happened twice to Alex, first when he reached for the doorknob he got a shock. Next time, when he pulled off his hat, all his hair stood on end. “What is going on?” Alex asks
Can you explain to Alex why this happened to him? To do so, first conduct this experiment which may help you:

Materials: comb or ruler, woollen cloth and paper

PROCEDURE
Predict what will happen when you hold the comb near the bits of paper



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Cut the paper to bits and hold the comb near them and write down your observation
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Rub a comb with a woollen cloth. Tear up bits of paper into small pieces. Hold the comb near the bits of paper and write down your observations
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In your group, discus the problem and then write down your final interpretation
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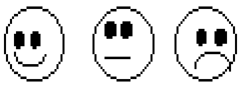
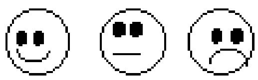
Reflective Feedback:

How did you feel about this activity?



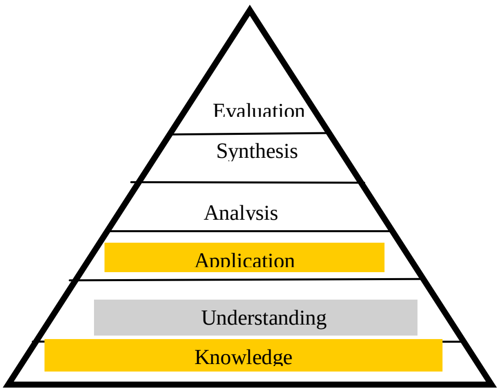
Would you like to do this activity again?



Electricity
Activity 1
Extension Activity

Repeat the last experiments using other materials such as a plastic pen, and write your observations.

Electricity
Activity1
Teacher Sheet

Essential Learning	**Focus Essential Learning** 1. Knowledge & thinking ▪ Experiment ▪ Observation ▪ Prediction ▪ Inferring 2. The content of Essential Learning ▪ Demonstrate that objects can be charged by friction. ▪ Understand the concept of static electricity.  **Supporting Essential Learning** ▪ Develop interest and enthusiasm toward exploring and investigating statistic electricity. ▪ Develop an interest in and enthusiasm for investigating concept of static electricity.
Time	20-30 minutes
Teacher background information	Each atom is made of protons, neutrons and electrons. Protons have a positive charge (+), electrons have a negative charge (-) and neutrons have no charge. The protons and neutrons in the nucleus are held together very tightly. Normally the electrons can move from one atom to another by many ways, one of them is to rub two objects together.
Activity description	In this activity students will be using sample equipment such as comb, pencil or ruler to observe how some materials can be charged and attract different subjects. Students will work in groups to do the activity, discuss what they observe and then answer the questions individually. Students should assess themselves at the end of activity. The last 10 minutes of the period, discuss with the students their answers and be sure that there is no misunderstanding about friction.
Prepare students for the activity	Ask students to bring the experimental materials one day before implementing the experiment.
Doing the activity	In groups
Extension activity	As you observe your students while they are working and assist them when they need it, you would obtain some idea about students' progress. So, assessment of students work against the rubric will be easier. Students who scored less than 2 in the rubric, do not mark their work and give them chance to complete their activity at home, if they showed low level of achievement give them extension homework (EHW1). This procedure will encourage students to keep looking for improvement in their performance and to be more serious about accomplishing their work.

Electricity
Activity 2

STATIC ELECTRICITY- CHARGES

Adapted form: Office of Science & Math Education (n.d.), *Get A Charge*: Illinois State Board of Education, from www.sciencemadesimple.com

Student Sheet

NAME:... SCHOOL ....

Your teacher will assess your work according to these criteria

Rubric

Excellent	Good	Satisfactory	Needs Improvement
Used observation to understand the repellence process between two subjects. Answered all questions correctly. Provided appropriate illustration for what was observed. Demonstrated in-depth understanding of the concept of static electricity.	Used observation to understand the repellence process between two subjects. Answered most questions. Providing illustration for what was observed. Demonstrated understanding of the concept of static electricity.	Used observation to understand the repulsion process between two subjects. Answered some questions. Providing some relevant illustration for what was observed. Showed a little understanding of the concept of static electricity.	Answers may be totally incorrect or irrelevant. Blank/no response

Teacher Comments
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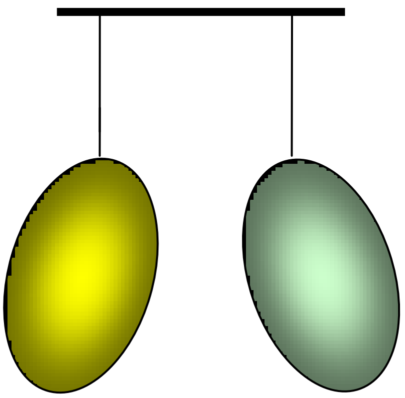
Electricity
Activity 2

Invitation
You know that static electricity causes attraction between two objects, but what about repellence? How can you find out that static electricity causes repellence as well?

MATERIALS
2 balloons
Woollen cloth
String 30 cm.
Plastic wrap



Hypotheses:

I think that when the balloon is charged with the woollen cloth it will be ....to another balloon
I think that when two balloons are charged with woollen cloth they will ....each other.

Procedures:

1. Blow the balloons. Tie each balloon at the end of a 30 cm. string.

2. Rub one balloon with the woollen cloth. Dangle the balloons by holding the centre of the string. Observe what happens.

   ....
   ....

3. Charge both balloons with the woollen cloth. Dangle the balloons by their string. Observe and record what happens.

   ....
   ....
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4. Did your observation support your hypotheses?

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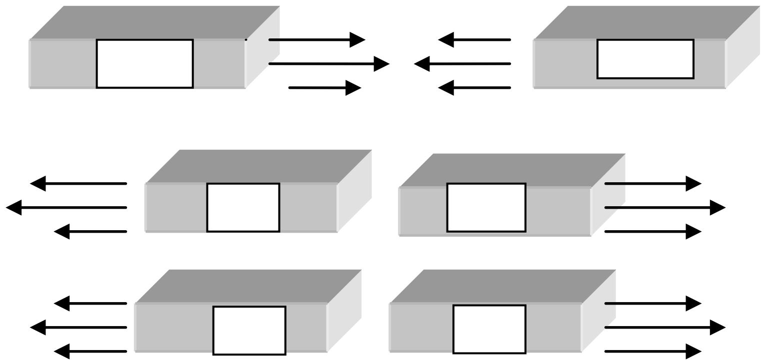
Write inside each box the kind of charge that make the boxes attract or repel and explain your answer



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What conclusion can you draw from this experiment?

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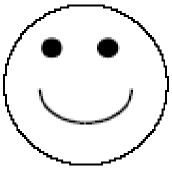
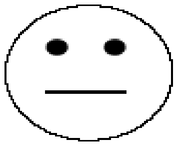
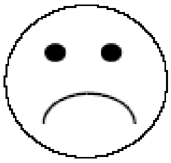
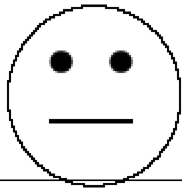
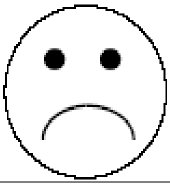
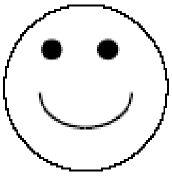
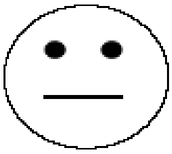
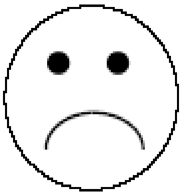
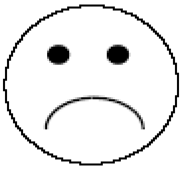
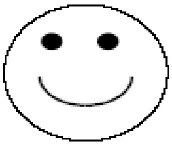
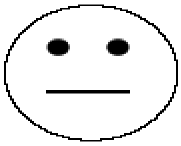
Student Self-Assessment

I followed instructions to perform an experiment with static electricity.			
I tested the hypotheses and recorded my observation.			
I can explain how attraction and repellence occur.			
I participated effectively in my group.			
I feel about this activity.			

If I could continue working in this activity I would try to understand:
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The most interesting thing I learned was:
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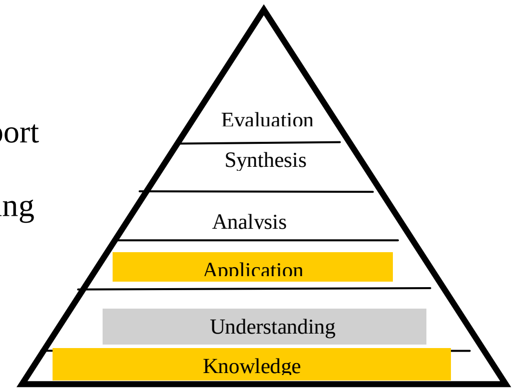
I liked this week's activities	a lot ☐	okay ☐	not much ☐
This week's activities were	too hard ☐	just right ☐	too easy ☐
During this week's activities I learned	a lot ☐	a little ☐	not much ☐

Electricity
Activity 2
STATIC ELECTRICITY- CHARGES

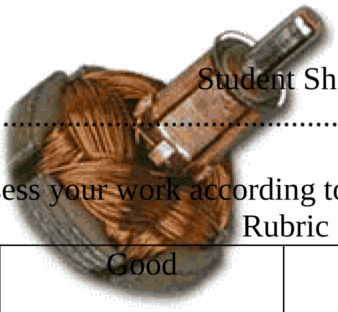
Teacher sheet

Objective	**Focus Essential Learning** 1. Knowledge & thinking ▪ Experiment ▪ Observation ▪ Writing an experiment report ▪ Hypotheses 2. The content of Essential Learning ▪ demonstrate that unlike charges attract and like charges repel  **Supporting Essential Learning** ▪ Develop interest and enthusiasm toward exploring and investigating properties of science. ▪ Seek and weigh evidence before drawing conclusion
Time	30-40 min.
Teacher background information	Normally, the atoms within an object are neutral, having an equal number of electrons (-) and protons (+). However, friction between certain materials causes electrons to move from one object to the other. When electrons are added to a material, the material has a negative charge. When electrons are taken from a material, the material has a positive charge. Electrical charges caused by friction are called static electricity. Materials with like charges repel each other. Materials with unlike charges attract each other.
Activity description	In this activity, students will use two balloons to investigate the concept of attraction and repellence by charging one and then two balloons using a wool cloth. Students should infer the relationship between the kind of charges and the concepts of attraction and repellence.
Prepare students for the activity	Ask students to bring the experimental materials one day before conducting the experiment.
Doing the activity	In pairs or in groups.

Electricity
Activity 3

Making a Simple Generator

Adapted from: Council of Chief State School Officers (CCSSO), More Power to You, http://pals.sri.com/tasks/5-8/Morepower/directs.html



Student Sheet

NAME:.. SCHOOL ....

Your teacher will assess your work according to these criteria

Rubric

Excellent	Good	Satisfactory	Needs Improvement
Successfully followed all instructions. Accurately recorded observation in the table. Inferred the relationship between the speed of moving a magnet and the amount of current that flowed along the wire. Correctly described the effect of moving a magnet into a tube in the direction of the compass needle	Successfully followed most instructions. Accurately recorded his observation in most table cells. Partly inferred the relationship between the speed of moving a magnet and the amount of current that flowed along the wire. Described with few errors the effect of moving a magnet into a tube on the direction of the compass needle	Successfully followed some instructions. Accurately recorded his observation in some table cells. Indicted the relationship between the speed of moving a magnet and the amount of current that flowed along the wire. Described with some errors the effect of moving a magnet into a tube in the direction of the compass needle	Answers may be totally incorrect or irrelevant. Blank/ no response

Teacher Comments

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Electricity
Activity (3)

Electricity can be obtained from several sources such as batteries and solar power, but the essential source of electricity is the electrical generator. How does the generator work? How can a generator be made? This is what we are going to find out in this activity.

Materials

- compass
- cardboard tube (e.g. from roll of toilet paper)
- bottom from cardboard box
- one length of 22 gauge insulated magnetic wire marked galvanometer, the wire should have alligator clips on its ends.
- one length of 22 gauge insulated magnetic wire marked generator, the wire should have alligator clips on its ends.
- strong bar magnet with its north pole marked N tape

Procedures:

1. Fold the flaps of the cardboard box as shown in Figure A below.

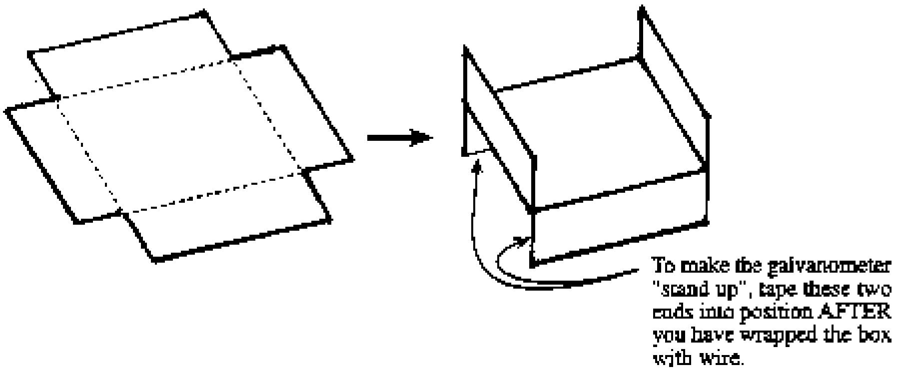
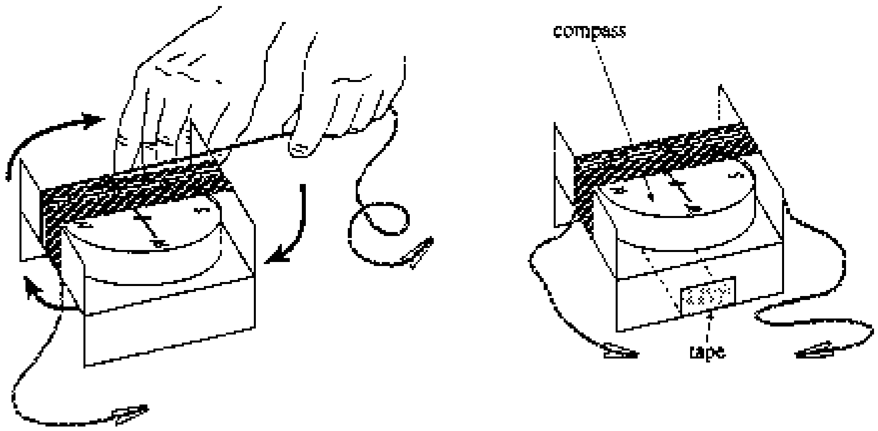


Figure A

2. Wrap the box with the magnet wire marked galvanometer. Leave about 15 cm. of unwrapped wire at each end, as shown in Figures B and C below.



Figures B and C

17

3. Place the compass in the wrapped cardboard box.
4. Wrap 50 turns of the wire marked generator around the cardboard tube. Leave at least 15 cm of extra wire at each end, as shown in Figure D below.

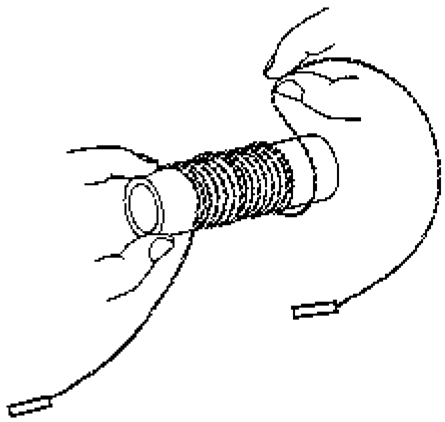


Figure D

5. Using the alligator clips as shown in Figure E, clip one end of the galvanometer wire to one end of the generator wire. Clip the other end of the galvanometer wire to the other end of the generator wire.

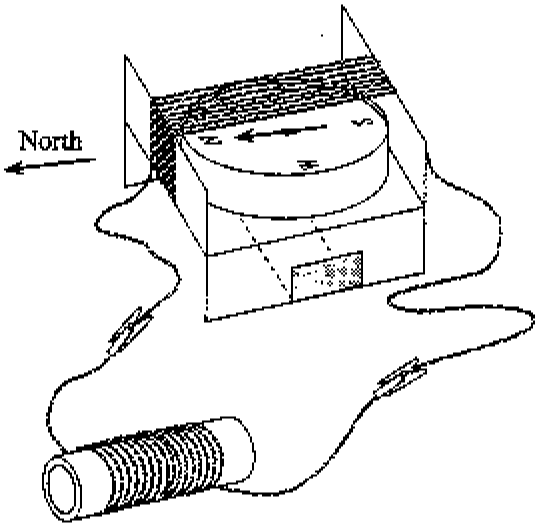


Figure E

Observations
Before each of the following trials, separate the magnet and the galvanometer by several meters, and orient the galvanometer so that the compass needle points north. Then, during each trial, note the direction and the amount (in degrees) of the needle's deflection (west of north or east of north) as the tip of the magnet enters or leaves the tube. As the amount of current flowing in the wire increases, the amount of deflection will increase. For example, figure F illustrates a deflection of 45 degrees east of north.

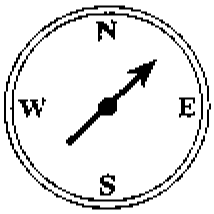


Figure F

After each trial, record your observations in the Data Table on the following page.
For trials 1-3, place the tip of the North pole of the magnet just inside the cardboard tube. The tube should be held still during trials 1-3.
Trial 1. Hold the magnet still with the tip just inside the tube.
Trial 2. Move the magnet slowly toward the tube as shown in Figure G; when the tip of the magnet is just inside the tube, stop. Then move the magnet slowly away from the tube and, when the magnet is 2 meters away from the tube, stop.

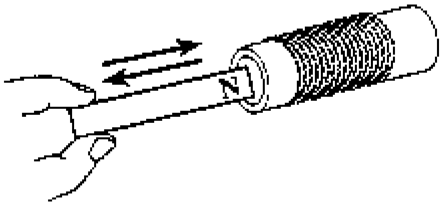


Figure G

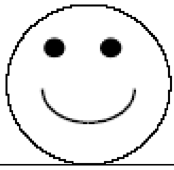
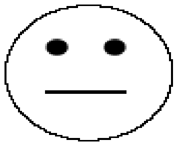
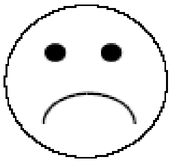
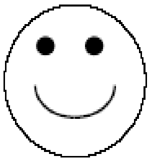
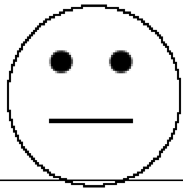
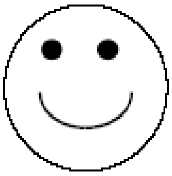
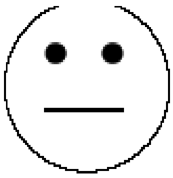
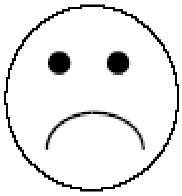
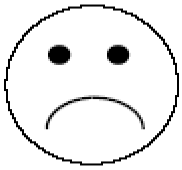
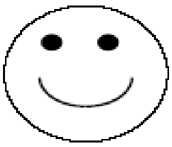
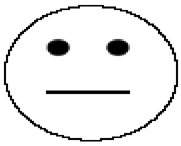
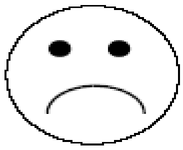
Trial 3. Move the magnet rapidly toward the tube; when the tip of the magnet is just inside the tube, stop. Then move the magnet rapidly away from the tube and, when the magnet is 2 meters away from the tube, stop.
For trials 4-6, place the South pole of the magnet inside the same end of the tube as before. The tube should be held still during trials 4-6.
Trial 4. Hold the magnet still with the tip just inside the tube.
Trial 5. Move the magnet slowly toward the tube until the tip of the magnet is just inside the tube, stop. Then move the magnet away from the tube and stop as in step 2.
Trial 6. Move the magnet rapidly toward the tube until the tip of the magnet is just inside the tube and stop. Then move the magnet rapidly away from the tube and stop as in step 3.

Data Table

Trial	Pole of magnet inside tube (N or S)	Motion of magnet relative to tube (none, slow, fast)	Amount of deflection (degrees) as magnet moves:		Direction of deflection (E for east of north; W for west of north) as magnet moves:	
			toward tube	away from tube	toward tube	away from tube
1	N	none				
2	N	slow				
3	N	fast				
4	S	none				
5	S	slow				
6	S	fast				

Based on your results, describe the relationship between: (a) how fast you moved the magnet and the amount of current that flowed in the wire; and (b) the pole of the magnet (north or south) that was inside the tube and the direction of the compass's deflection.

Student Self-Assessment

I followed instructions to perform an experiment.			
I recorded my observation on the table.			
I understand how to apply the materials to construct a generator.			
I participated effectively in my group.			
I feel about this activity.			

If I could continue working in this activity I would try to understand:
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The most interesting thing I learned was:
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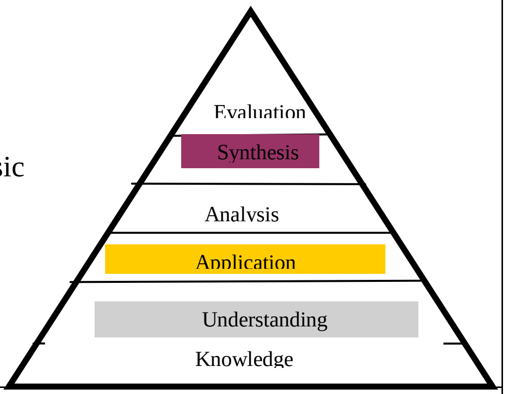
Electricity
Activity 3
Extension

You live along a moving river, and you have a wire, a paddle wheel, and a bar magnet. Describe how you could use these materials to produce an electrical current. Include a diagram of your setup in your description.

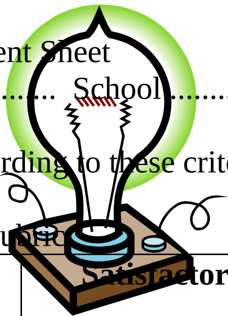
Electricity
Activity (3)
Teacher Sheet

Essential Learning	**Focus Essential** 1. Knowledge & thinking ▪ Experiment ▪ Observation ▪ Inferring 2. The content of Essential Learning ▪ Produce electricity by using basic materials. **Supporting Essential** ▪ Recognise the importance of guidelines for experimentation ▪ Demonstrate a sense of curiosity about science. 
Time	30-40 minutes
teacher background information	The simple galvanometer is used to detect the presence of an electric current and to determine the amount of the current. When a magnet is moved into or out of the coils of wire that are wrapped around the tube, the changing magnetic field intensity inside the tube creates a voltage along the wire. Increasing the rate of change of the field's intensity (in this case moving the magnet more rapidly into or out of the magnet) or increasing the number of turns of wire around the tube will increase the voltage. The voltage inside the wire causes a current to flow inside the wire, so as the voltage gets higher, the current gets larger. The current produces a second magnetic field, some of which occupies the space containing the compass, so as the current gets larger, the second magnetic field gets more intense. The second magnetic field causes the compass's needle to be deflected, so as the second field gets more intense, the deflection of the needle gets larger. Therefore, when a student rapidly moves a magnet into or out of the tube, the deflection of the compass needle should be larger than when the magnet is moved slowly. Finally, the direction of the compass needle's deflection depends on which pole of the magnet is pointed toward the tube and on whether the magnet is moving into or out of the tube.
Prepare students for the activity	Each student will need two wires- one will be for the "generator" and one will be for the "galvanometer" To make these wires- cut lengths of 22 gauge insulated magnet wire (looks like plain copper wire) so that the wires are sufficiently long to make 50 turns around the box with 30 cm left over. Attach alligator clips to both ends of each wire. Label one wire "Galvanometer" and one wire "Generator" for each student. Label the North Pole "N" on each bar magnet. The student will need a "box bottom" that is unassembled. If boxes are assembled- simply cut the side corners of each box so that sides can be positioned flat on the table.
Doing the activity	In groups
Extension activity	As you observe your students while they are working and assist them when they need it, you would obtain some idea about students' progress. So, assessing students work against the rubric will be easier. For students who scored less than 2 in the rubric, do not mark their work and give them chance to complete their activity at home, if they showed low level of achievement give them extension homework. This procedure will encourage students to continue to look for improvement in their performance and be more seriously for accomplish their work.

Electricity
Activity 4

Circuits

Adapted from: Brown & Shavelson, Assessing Hands-On Science (1996); Office of Science & Math Education (n.d.), *Get A Charge*: Illinois State Board of Education, from www.sciencemadesimple.com



Student Sheet

Name... School..

Your teacher will assess your work according to these criteria.

Rubric

Excellent	**Good**	**Satisfactory**	**Needs Improvement**
Correctly made a circuit. Successfully added the switch. Inferred the function of the switch. Accurately and neatly recorded the experiment. Showed a deep understanding of circuits.	Made a circuit with some errors. Added the switch. Partly inferred the function of the switch. Recorded the experiment with a few errors. Showed a reasonable understanding of circuits.	Had difficulty in making the circuit and switch. Reported few details. Showed little understanding of circuits.	Answers may be totally incorrect or irrelevant. Blank/ no response

Teacher Comments

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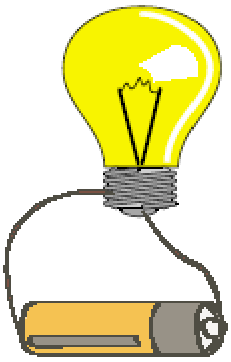
Electricity
Activity 4

Invitation
Have you used a bright flashlight? Have you seen a car light? How can you make a bulb light?

Material: Battery, bulbs and wires


Procedures:



Connect one battery, one bulb and 2 wires.
Did the bulb light?
What you are doing now is making a circuit, why do you think it is called a "circuit"?
……………………………………………………………………………
…………………………………………………………………..…….

Add a switch to the circuit which you made
Open and close the switch. What do you observe?
……………………………………………………………………………
…………………………………………………………..……………………..

How does the switch work?

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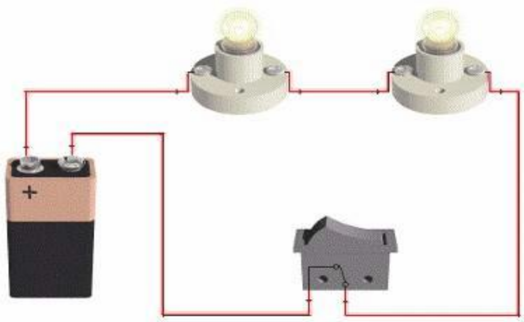

Add another bulb following what you see in the diagram

Write the experiment report on the next page

Activity 4
Experiment Form

Scientist:

Title of Activity:

Observation: What caused you to ask the question?

Question: What do you want to find out?

Hypothesis: What do you think you will find out?

Procedure: How will you find it out? (List step by step. Use the back of this page if necessary.)

1.
2.
3.
4.

Result(s): What actually happened?

Conclusion(s): What did you learn?

Student Self-Assessment

Put (√) under the number you think represents your performance. For example if you think you completely followed the instructions, put (√) under (4), if you think you followed most instruction put (√) under (3). So, (4) means the highest mark and (1) the lowest.

Parameter	**1**	**2**	**3**	**4**	**I'm not sure**
I followed instructions					
I can make a switch.					
I understand the function of a swatch.					
I Drew the diagram of a series circuit.					
I did a full share of the work with my group.					
I demonstrated responsibility in my group.					
I value scientific information that I have learned from this activity.					

If I could continue working in this activity I would try to understand:
....
....
....
....

What I learned in this activity is:
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Activity 4
Extension I

Name -------------------------------------- School ---------------------------------------

Try to make a circuit with two bulbs, but in a different way to what you have already made

Draw a diagram of the circuit that you made

Explain how you made it

....
....
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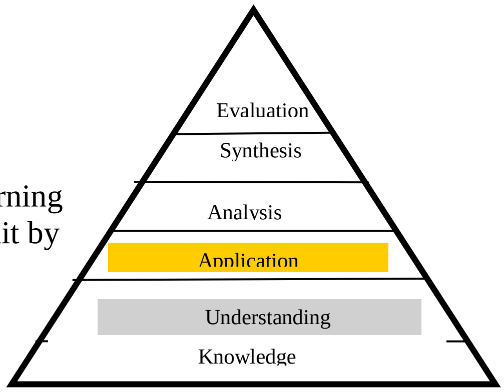
Electricity
Activity 4

Teacher sheet

Objective	**Focus Essential Learning** 1. Knowledge & thinking ▪ Experiment ▪ Observation ▪ Inferring 2. The content of Essential Learning ▪ Construct a closed circuit by making a bulb light. ▪ Create a simple switch by using basic materials. ▪ Demonstrate and describe the function of switches in electrical circuits. ▪ Construct simple series circuit. **Supporting Essential Learning** ▪ Develop an awareness of the importance of science in our lives. 
Time	30-40 min.
Science facts	Electricity has to travel a complete circuit or path. In other words, electricity will always try to travel in a loop. A switch works by interrupting the flow of electricity through the circuit. When the switch is turned off, the light bulb can't light because there is a gap, or break, in the wire inside the switch. When you turn the switch on, a small piece of metal inside the switch bridges the gap, making a complete circuit
Activity description	In this activity, students will make a complete circuit by attaching the end of one wire to the positive (+) end of the battery and by using the other end of the same wire to connect to the positive end of the socket. At the same time they should attach another wire to the negative (-) end of the socket. Then, they should complete the circuit by attaching the other end of the wire to the negative end of the battery. Students will also make a switch and experiment with how it works. Finally, they will add one bulb to the circuit to make a series circuit and recognize its characteristics.
Doing the activity	In groups

Electricity
Activity 5

Conductors and insulators
Adapted from: Brown & Shavelson, Assessing Hands-On Science (1996); www.NASAexplores.com, http://www.edu.gov.mb

Student Sheet

Student name……………………………………………School...................................

Your teacher will assess your work according to these criteria

Rubric

Scoring Criteria	**1**	**2**	**3**	**4**
Followed instructions				
Recorded his predictions, tested materials and recorded his observations.				
Classified materials as conductors or insulators				
Made an inference about using conductors and insulators				
Drew a diagram for the circuit with two bulbs				

Scoring Key
4 points Correct, complete, detailed
3 points Partially correct, complete, detailed
2 points Partially correct, partially complete, lacks some detail
1 point Incorrect or incomplete, needs assistance

Teacher Comments

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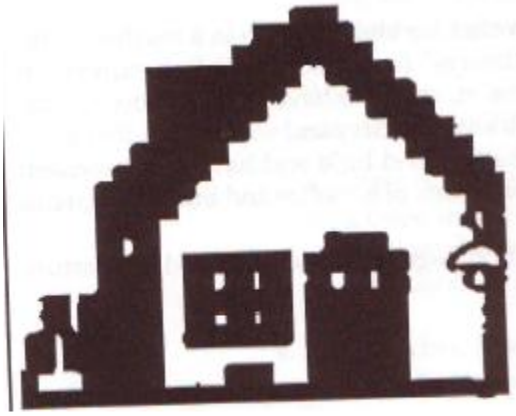
Electricity
Activity 5

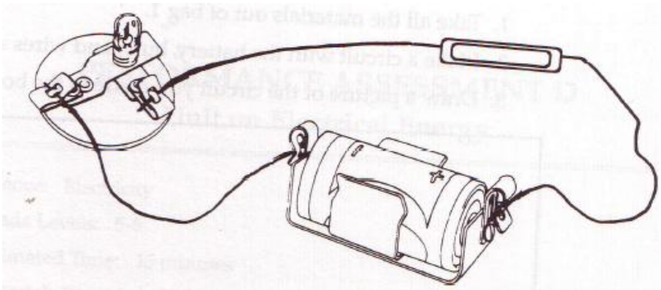
Lighting project

Look at the house on the right; it needs light for the external door. You will design a light model. So, your task in this activity is to:
Select the appropriate materials that can be used in the connection of electricity and the materials used to insulate wires.
Make a small model of a circuit with two bulbs.



Materials:
Batteries, wires, light bulbs

Part2
Use your conductivity to see if some materials (paper clip, plastic ruler, nail, sponge,..) conduct electricity



Predict whether each substance will be an insulator or a conductor prior to the experiment

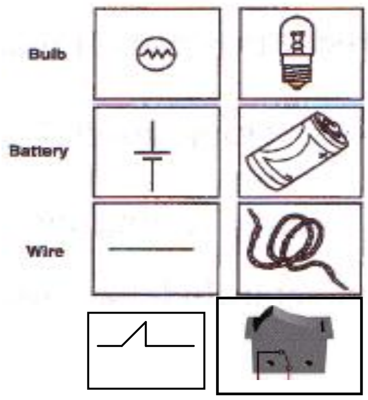
Objects tested	Prediction (before the experiment)		Find from the experiment	
	Insulator	Conductor	Insulator	Conductor

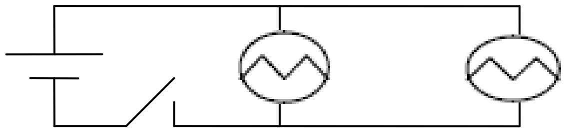
2. Were all of your predictions correct? ....

Identify potential applications of your experimental findings (e.g., which material would be best to insulate a wire? Which material would be best to conduct electricity in a switch?)

Part 2

Make a circuit according to this diagram.





Draw the diagram of the circuit you made

Student Self-Assessment

Put (√) under the statement showing your understanding

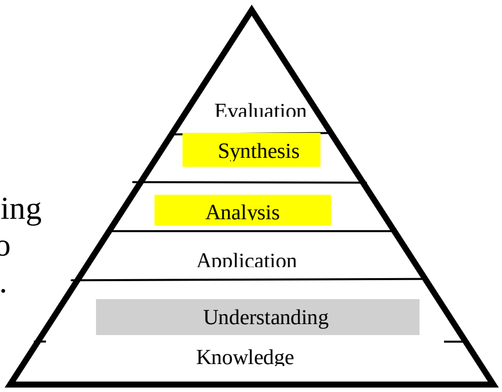
Item	1	2	3	4
Conductors and insulators	I would like to redo the experiment to learn more about conductors and insulators	I'm not sure if I can distinguish between conductors and insulators	I can distinguish between conductors and insulators just by experimenting	It is easy to distinguish between conductors and insulators just by experiment
	☐	☐	☐	☐
The use of conductors and insulators	I don't know any use for conductors and insulators	I can determine a few uses for the conductors but I'm not sure what materials are used as insulators or conductors	I can determine some uses of the conductors materials but I'm not sure what insulator materials are used for (or the opposite)	I can clearly mention many uses for conductors and insulators
	☐	☐	☐	☐
Make circuit by using diagram	I cannot make a circuit by using diagram	I' m not sure if I can make a circuit according to an illustrated diagram	I can make a circuit according to an illustrated diagram with some difficulty	I can easily make a circuit according to an illustrated diagram
	☐	☐	☐	☐

If I could continue working in this activity I would try to understand:
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

The most interesting thing I learned was:
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Activity 5
Switch

Teacher Sheet

Objective	**Focus Essential Learning** 1. Knowledge &thanking ▪ Experiment ▪ Observation ▪ Inferring 2. The content of Essential Learning ▪ Classify some materials to conductors and insulators. ▪ Construct a simple parallel circuit. ▪ Draw a diagram of simple series circuits  **Supporting Essential Learning** ▪ Develop an interest in and enthusiasm for investigating scientific phenomena.
Time	20-30 minutes
Science facts	A circuit is a complete path around which electricity can flow. It must include a source of electricity, such as a battery, and wire allows electrons to move through. Some materials allow the electric current to flow freely whereas some do not. Metals, such as copper, are conductors. The conductors imply that the outer electrons of the atoms are loosely bound and free to move through the material. Whereas, the atoms in insulators hold onto their electrons tightly.
Activity description	In this activity, students will create an electrical circuit and investigate whether some materials conduct electricity. Students should predict the conductors and insulators before implementing. In Part2, students will make a parallel circuit following a diagram.
Doing the activity	In groups.
Extension the activity at home	In addition to regular homework you can give students who show misunderstanding some extra homework.

Electricity
Activity 6

The benefits of electricity

Group.......
Student names:
1- ....
2- ....
3- ....
4- ....
5- ....

Group work will be assessed according to these criteria

Criteria	**Score**
▪ Name most devices that use electricity. ▪ Classify all of them into appropriate groups ▪ Order the devices in terms of increasing electricity consumption ▪ Suggest creative ways for reducing the consumption of electricity	4 Excellent
▪ Name many devices, most of them related to electricity ▪ Classify most of them correctly into appropriate groups ▪ Order most devices according to their consumption of electricity ▪ Suggest many useful ways to reduce the consumption of electricity	3 Proficient
▪ Name some devices, few of them related to electricity ▪ Order few devices according to their consumption of electricity ▪ Suggest few useful ways to reduce the consumption of electricity.	2 Marginal
▪ Address the questions in a very limited way	1 Unsatisfactory

Electricity
Activity 6

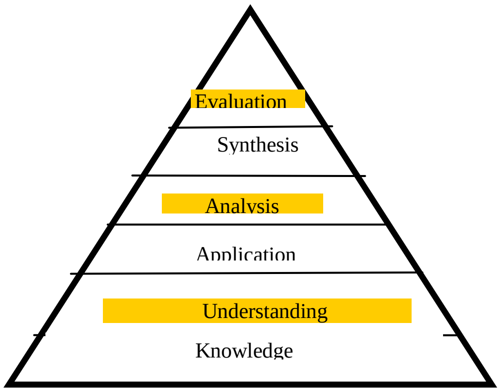
Invitation

Electricity has become an essential element in our lives, we use it in many different ways, however it costs us a bill which we have to pay regularly. In a group, name the electrical devices that you use in every day life and suggest ways to reduce their electricity consumption.

With your group, list as many electrical devices as you can, and sort them into groups according to how the electricity is used (for lighting, cooling, heating, cleaning, entertaining ....)
Order the devices that you listed according to their consumption of electricity.
Suggest ways for reducing the consumption of electricity.

Activity 6

Teacher Sheet

Objective	**Focus Essential Learning** ▪ Use appropriate vocabulary related to their investigations of electricity. ▪ List electrical devices used at home, at school, and in the community, and identify the human needs that they fulfil.  **Supporting Essential Learning** ▪ Develop an interest of the importance in science in our lives.
Time	30-40 minutes
Doing the activity	In groups
Description of the activity	In this activity students will think of count some electrical devices and classify them into groups according to their use. Students will also suggest some methods to reduce the consumption of electricity and present their suggestions to other groups.

Electricity
Task 1
Batteries Task

Adapted from: Batteries, Chapter1, Students Achievement on The Performance Assessment Tasks, TIMSS,1995, http://timss.bc.edu/timss1995i/TIMSSPDF/PAchap1a.pdf

Student Name……………………………………. School ………………………….

At this station you should have:

A flashlight (or torch)
Four batteries in a plastic bag: Batteries A, B, C, D
Read ALL directions carefully.
Your task:

Find out which of the batteries are good and which are worn-out.

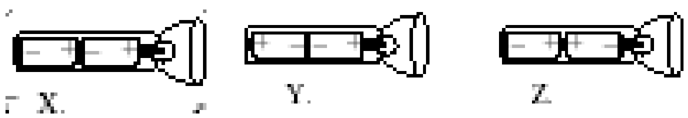
This is what you should do:
• Think about how you could solve this problem.
• Then work out which batteries are good and which are worn-out.

Based on your investigation which of the batteries are good and which are worn-out? Write the letters of the batteries in the spaces below.

Good batteries ______________________________________
Worn-out batteries ___________________________________

2. Write down how you decided which batteries were worn-out.

3. How should the batteries be put in the flashlight to give the brightest light? Here are 3 different ways of putting the batteries in the flashlight. Draw a circle around the picture that you think shows the correct way.



4. Why is the way you chose the best way to put in the batteries?

Battery Task
Teacher Sheet

In the Batteries task, students were provided with four unmarked batteries and a flashlight. To begin, they were asked to find out which of the batteries were good and which were worn out.
The task was designed to measure students' ability to develop and implement problem-solving strategies and to use experimental evidence to support a conclusion, but it also sampled specific knowledge about electricity to solve a routine problem and to develop a concept-based explanation for the solution. Item 1 required students to identify the good batteries, which could be achieved by a systematic process of trial and error. Item 2 called for a description of the strategy used to identify the good batteries. Item 3 required a selection of the correct arrangement of batteries in a flashlight. Item 4 asked students to explain why their solution was correct, which requires knowledge of the concept of a complete circuit and an understanding of the direction of flow of electrical current.

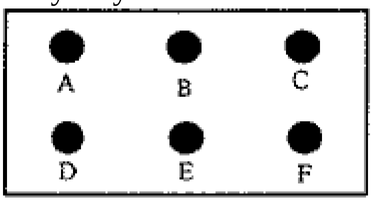
CRITERIA FOR FULLY-CORRECT RESPONSE
Item 1 - Identify which batteries are good and which are worn out.
All batteries correctly identified (per administrator notes).
Total Possible Points: 2
Item 2 - Describe how worn-out batteries were identified.
i) Shows evidence of systematic and definitive testing of different combinations of batteries.
ii) "Systematic" is evidenced by trying all combinations of batteries or trying selected combinations using reasoning and scientific knowledge to eliminate some trials.
Total Possible Points: 2
Item 3 - Identify which arrangement of batteries inside flashlight will produce the brightest light. Correct arrangement identified (X).
Total Possible Points: 1
Item 4 - Explain why chosen arrangement is the best one.
i) Identifies correct arrangement.
ii) Includes concepts of complete circuit and/or current flowing in one direction.
Total Possible Points: 2 (Total scores for this task = 8/2= 4)

Electricity
Task2
Mystery Card

Adapted from: Mystery Card 3, New York State Education Department (NYSED) NYS Alternative Assessment in Science Project (1996), http://pals.sri.com/pals/tasks/k-4/Mystery3/

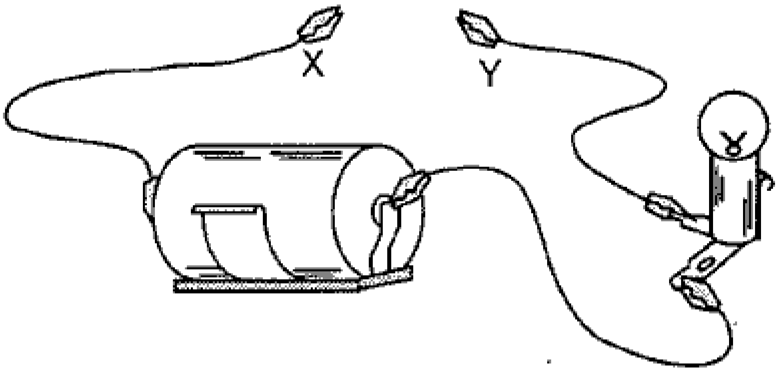
You will be using an electrical tester to determine where electricity flows between circles on a mystery card.

Materials:
1 electrical tester
1 mystery card



Mystery Card

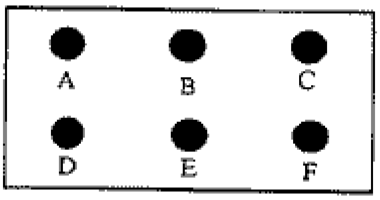
The diagram below represents an electrical tester.



Directions:
Look at the electrical tester in front of you and make sure that it looks like the electrical tester shown in the diagram above.
Touch the free ends of the wire clips together to see if your bulb will light up. If it doesn't, please raise your hand to let the teacher know right away.
Touch circle A on the mystery card with one wire clip. AT THE SAME TIME, touch circle B with the other wire clip.
If the bulb lights, put a check in the YES column in the chart, on the next page.
If the bulb does not light, put a check in the NO column in the chart.
Do the same for all of the other pairs of circles on the mystery card. Be sure to record all of your results in the table.

Touching			Bulb Lights	
			YES	NO
A	→	B		
A	→	C		
A	→	D		
A	→	E		
A	→	F		
B	→	C		
B	→	D		
B	→	E		
B	→	F		
C	→	D		
C	→	E		
C	→	F		
D	→	E		
D	→	F		
E	→	F		

On the basis of your findings, draw a diagram which shows a possible way the circles on your card could be connected with wires. Use lines to show where the electricity travels.

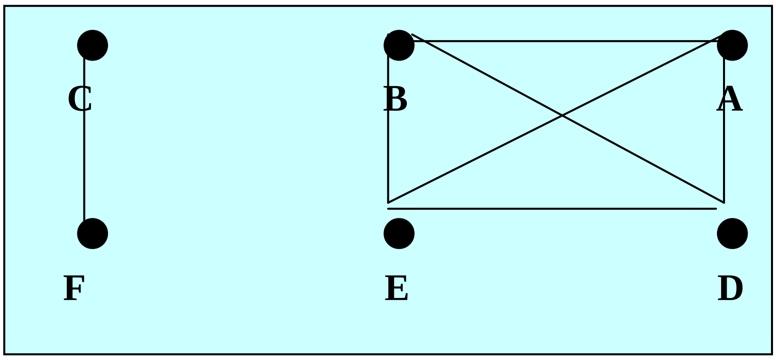


Electricity
Task 2
Teacher Sheet

In this task, a student tests the circles on the mystery card and correctly indicates which connection made the bulb light or not light. He then makes a valid drawing based on data from the table.

The correct answers

	Touching	
	No	Yes
A → B		✓
A → C	✓	
A → D		✓
A → E		✓
A → F	✓	
B → C	✓	
B → D		✓
B → E		✓
B → F	✓	
C → D	✓	
C → F		✓
C → E	✓	
D → E		✓
D → F		✓
F → E	✓	



CRITERIA FOR FULLY-CORRECT RESPONSE
One score for each correct link, the whole mark for the table 15/3. One score for drawing correctly the diagram. Total possible scores: 4

Electricity
The projects

Choose one of the following projects

Battery life:
In this project you will experiment three brands of batteries to determine which one stays longer.

Requirement: collect three torches or one torch and three new batteries of the same size from different brands.

Electricity consumption:
In this project you will discover in which season we consume more electricity and in which season we consume less, determining the main reasons in each case, and suggesting some solutions to reduce electricity consumption.
Requirement: collect at least one electricity invoice for each one of the four seasons of the year.

- Use a graph to illustrate your results.
- Find pictures for more electrical devices that are used.
- Choose four electrical sources and develop a plan for reducing electrical energy consumption at home, at school or in the community.

Brochure:
In this project you will act as a seller of electrical devices who wants to make commercial advertising to inform people of the features of his devices.
Requirement: collect some posters or photos for some electrical devices.

Making a Simple Generator

You are required in this project to make a simple generator
Requirement: collect a piece of copper wire about two metres long, a bar magnet, and a compass.

Follow these directions to make a simple generator:

- Wrap one end of the wire around your hand about 10 times to make a coil. Slide the coil off your hand.
- Wrap the other end of the wire around the compass about five times.
- Twist the two ends of the wire together.
- Slide the magnet quickly back and forth inside the coil.
- Look at the compass. What is happening? (The moving needle in the compass shows that electricity is flowing through the wires.)
- Record your findings in your science notebook.

General instructions

- Once you choose your project ask your teacher for more details and then make a plan for conducting the project and discuss it with the teacher.

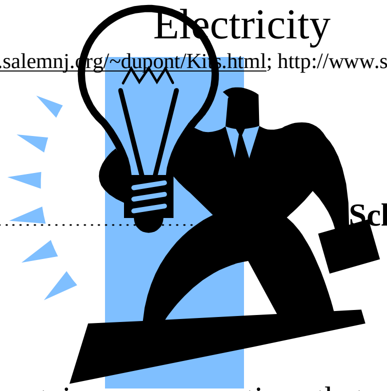
- Your work on the project will be in several stages, and your teacher will follow you in each stage.
- The project must be your own work. Any work done by others will not be accepted.
- You can request the assistance of your parents or others, but you must mention the names of each person who helped you, or sources from which you benefited.

Your work will be evaluated according to this rubric

Criteria	Excellent	Very good	Good	Needs to improve
Work plan	The plan of work is very clear and ranked in points, applicable, and flexible	The plan of work is clear, applicable, organised, and flexible	The plan of work is somewhat clear and organised. Difficult to apply.	The plan is not clear and is inapplicable.
Conducting	All phases of the project were carried out under the supervision of the teacher. Teacher's guidance was folly followed amend or develop the work. Applied himself entirely to the work of the project.	Most phases of the project were carried out under the supervision of the teacher. Executed most teacher/s directives to amend or develop the work. Self-reliant to a large degree in project work.	Some phases of the project were carried out under the supervision of the teacher. Carried out some guidance teacher amend or development work, some phases of the work were carried out with direct help from anther person.	The project was not implemented under the supervision of the teacher. The work was carried out by another person.
Work quality	Work in at least three of the following characteristics: innovation, creativity, application of the concepts associated with the themes of science subject, the use of diagrams or illustrations forms. Clear evidence of good of good planning and implementation skills	Work in at least two of the following characteristics: innovation, creativity, application of the concepts associated with the themes of science subject, the use of diagrams or illustrations forms, Clear evidence of good of good planning and implementation skills	Work in at least one of the following characteristics: innovation, creativity, application of the concepts associated with the themes of science subject, the use of diagrams or illustrations forms, Clear evidence of good of good planning and implementation skills	Work is not good enough, or relied upon other sources
Commitment to implementing the project	Committed over all planning and met deadlines of each phase	Committed in most planning and met deadlines of most phases	Committed in some planning and did not meet deadlines of most phases.	Was late in submission of the work

Homework (1)
Electricity

Adapted from: http://www.salemnj.org/~dupont/Kids.html; http://www.sciencemadesimple.com/a5t63rrw.html



Student name …………………………………………… **School**……………………..………………

Homework instructions:

1. This homework contains many questions that you are supposed to solve during the week and return to your teacher at the beginning of the following week.
2. Do not answer all the questions once, but after each science lesson, do the questions related to the topic.
3. Homework aims to consolidate and advance your understanding of the topics you have studied in the school, or to help you understand what you were not able to understand in a lesson time. So, always try to do the homework in a timely manner.
4. If you can not understand any question, you can ask the teacher or one of your family members to explain it to you, and then solve the question yourself.
5. Homework will be corrected in accordance with the following rubric:

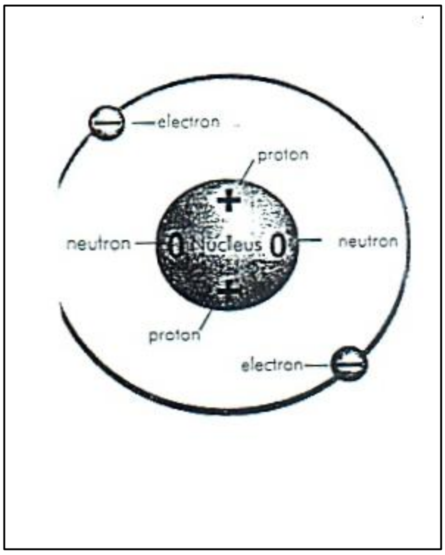
Rubric

▪ a student submitted the homework on time ▪ answered correctly all the questions ▪ the homework is clean and written clearly ▪ applied himself in doing the homework	4
▪ a student submitted the homework on time ▪ answered correctly most questions ▪ the homework is clean but the writing is not clear ▪ applied himself in doing the homework	**3**
▪ a student submitted the homework after one day ▪ answered correctly all or most the questions ▪ the homework is not clean ▪ applied himself in doing the homework	**2**
▪ delayed in the submission of the homework ▪ responded to some questions correctly ▪ the homework is not clean ▪ did not depend on himself to complete the work	**1**
▪ Will give additional time to complete the work	**0**

Add to your information

Everything is made up of atoms. At an atom's centre is the nucleus. It has two parts. One part is a proton. It has a positive charge (+). The other part is a neutron. It has no charge (0). Outside the nucleus are electrons. Each one has a negative charge (-). Every atom has the same number of protons and electrons. Since they are balanced, atoms have no charge. But electrons can travel.

How can we move electrons from one place to another? One very common way is to rub two objects together. If they are made of different materials, and are both insulators, electrons may be transferred (or moved) from one to the other. The more rubbing, the more electrons move, and the larger the charges built up. (Scientists believe that it is not the rubbing or friction that causes electrons to move. It is simply the contact between two different materials. Rubbing just increases the contact area between them.) .



It is useful to think of a model of the atom as similar to the solar system. The nucleus is in the center of the atom, like the sun in the center of the solar system. The electrons orbit around the nucleus like the planets around the sun. Just like in the solar system, the nucleus is large compared to the electrons. The atom is mostly empty space. And the electrons are very far away from the nucleus. While this model is not completely accurate, we can use it to help us understand static electricity.

Answer the questions below. Reread, if necessary.

What are all things made of? ______________________________________

What are the parts of an Atom? ______________________________________

What kind of charge does each part of an atom have? ____________

What part of an atom can travel? ______________________________________

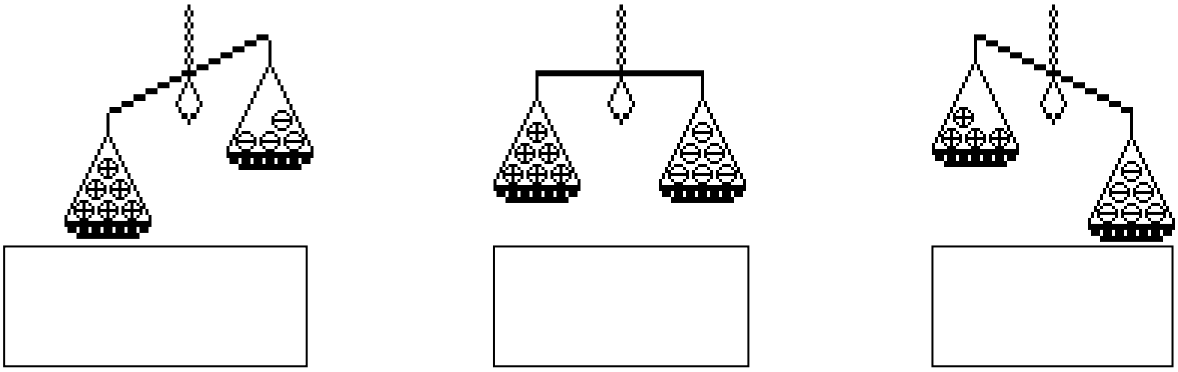
What happens when an object has more electrons than protons?

____

What is the similarity between the solar system and an atom?

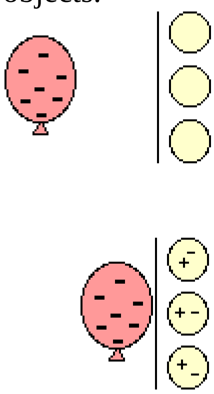
____

7. Write the kind of charge under each picture



Now, positive and negative charges behave in interesting ways. Did you ever hear the saying that opposites attract? Well, it's true. Two things with opposite, or different charges (a positive and a negative) will attract, or pull towards each other. Things with the same charge (two positives or two negatives) will repel, or push away from each other

A charged object will also attract something that is neutral. Think about how you can make a balloon stick to the wall. If you charge a balloon by rubbing it on your hair, it picks up extra electrons and has a negative charge. Holding it near a neutral object will make the charges in that object move. If it is a conductor, many electrons move easily to the other side, as far from the balloon as possible. If it is an insulator, the electrons in the atoms and molecules can only move very slightly to one side, away from the balloon. In either case, there are more positive charges closer to the negative balloon. Opposites attract. The balloon sticks. (At least until the electrons on the balloon slowly leak off.) It works the same way for neutral and positively charged objects.

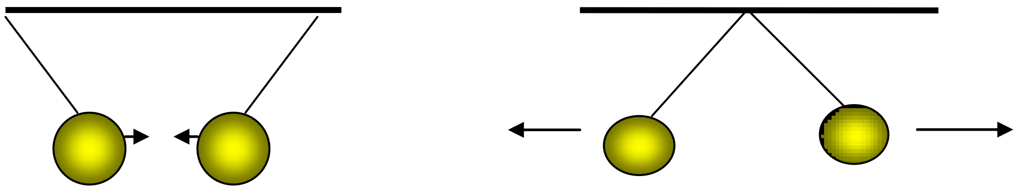


So what does all this have to do with shocks? Or hair full of static? When you take off your wool hat, it rubs against your hair. Electrons move from your hair to the hat. Now each of the hairs has the same positive charge. Remember, things with the same charge repel each other. So the hairs try to get as far from each other as possible. The farthest they can get is by standing up and away from the others. Bad hair day!

As you walk across a carpet, electrons move from the rug to you. Now you have extra electrons. Touch a door knob and ZAP! The door knob is a conductor. The electrons move from you to the knob. You get a shock.
We usually only notice static electricity in the winter when the air is very dry. During the summer, the air is more humid. The water in the air helps electrons move off you more quickly, so you cannot build up as big a charge.

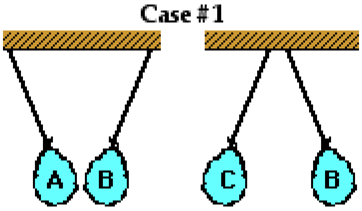
Answer the questions below. Reread if you have to.
1. Complete
A. The things with the same charge …………….. each other
B. The things with different charge .... each other

2. Write kind of charges under each picture



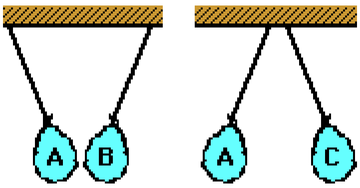
3. On two occasions, the following charge interactions between balloons A, B and C are observed. In each case, it is known that balloon B is charged negatively. Based on these observations, what can you conclde about the charge on balloon A and C for each situation?

Case #1



Object	Conclusive evidence to conclude the charge is +, – , neutral
A	
B	negative
C	

Case #2



Object	Conclusive evidence to conclude the charge is +, – , neutral
A	
B	negative
C	

4. Upon entering the room, you observe two balloons suspended from the ceiling. You notice that instead of hanging straight down vertically, the balloons seems to be repelling each other. What can you conclusively say?

....

....

5. Sam is investigating the charge on several objects and makes the following findings.

Object C	**Object D**	**Object E**	**Object F**
attracts B	Repels C	attracts D repels F	attracts A

Sam knows that object A is negatively charged and object B is electrically neutral. What can Sam definitively conclude about the charge on objects C, D, E, and F? Explain.

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Unit 10: Magnets

No	Learning Outcome
1	Students are able to: observe magnetic force with different materials
2	Deduce that magnets have two different poles
3	Infer that similar poles repel and different poles attract
4	Observe what will happen to magnetic poles when hung from the middle by twine
5	Name some uses for magnets in real life
6	Explain two ways to convert a pin to a magnet
7	Describe the appropriate way to store magnets
8	Describe magnetic poles

Magnets
Activity M1

Adapted from: Barre Town Middle and Elementary School (2004), www.vermontinstitutes.org/ assessment/pass_es/magnets/student.pdf; Magnets,www.michigan.gov. (2002). Lesson 1 - What's Attractive to Magnets?,http://www.michigan.gov/scope/0,1607,7-155-13481_13482_13485-37808--,00.html

Name:.. School ....

Your teacher will assess your work according to these criteria

Rubric

Excellent	Very good	Good	Needs to improve
Correctly answered all questions. Accurately predicted and tested the materials with a magnet. Correctly classified objects that are and are not attracted by magnets. Thoughtfully illustrated what was observed.	Correctly answered most questions. Accurately predicted and tested the materials with a magnet. Made a few errors classifying objects that are and are not attracted by magnets. Illustrated what was observed.	Correctly answered some questions. Had difficulty predicting and testing the materials with a magnet. Made many errors classifying objects that are and are not attracted by magnets. Provided some relevant illustration for what was observed.	Answers may be totally incorrect or irrelevant. Blank/ no response.

Teacher Comments

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Activity M1

The Barre Town Toy Company would like to make a new game using magnets. They need your help finding the best materials for this game. Since you are now an expert with magnets, please share what you know.

1. Work like a scientist and test the materials with a magnet. Record your results on the chart.

Object	Prediction	Experiment
	Yes/No	Yes/No
 rubber band		
 paper clip		
 marble		
 nail		
 chalk		
 twist tie		
 fasteners		
 coin		
 eraser		
 scissors		

2. Order the materials that are attracted/ not attracted to a magnet into two groups.

3. What do most of the materials that are attracted to magnets have in common?

3. Based on your work with magnets, tell the toy company how the objects that magnets attract are alike?

....

....

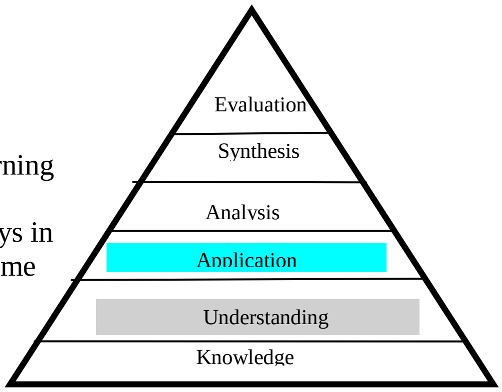
....

Student self-Assessment

Circle the number you think represents your performance or opinion about this activity (for example if you think the problem is easy put a circle around number 4, or circle number 3 if you think it is somewhat easy. If you think it is difficult, circle number 1)

I could not predict materials that react with magnets	1 2 3 4	I predicted materials that react with magnet
I could not classify the materials into two groups	1 2 3 4	I classified the materials into two groups
I can not describe the materials that are attracted to magnets	1 2 3 4	I described the materials that are attracted to magnets
I'm not satisfied with my work in the group	1 2 3 4	I satisfied with my work in the group
This activity is difficult	1 2 3 4	This activity is simple

Activity M1
Teacher Sheet

Essential learning	**Focus Essential Learning** 1. Knowledge & thinking ▪ observation ▪ prediction ▪ experimentation ▪ inference 2. The Content of Essential Learning Students should be able to: ▪ Experiment with the ways in which magnets affect some materials. ▪ Experiment in order to classify a variety of materials. ▪ Infer that the materials that are magnetic are made of iron.  **Supporting Essential Learning** ▪ Develop interest and enthusiasm toward exploring and investigating magnetism. ▪ Develop an interest in and enthusiasm for investigating the concept of magnetism.
Activity description	In this activity students should record their predictions. After the predictions are recorded, students should be given a magnet to test their predictions. They need to record their findings, then observe the behaviour of magnets with a variety of materials to determine whether or not a magnet is attracted to them. Students divide materials into two groups, one of them includes: rubber band, marble, chalk, twist tie, fasteners and eraser. In the last question (No.3) students should conclude that only metals contain iron.
Activity instructions	Divide students into groups. Let each student finish the first part of Question1, after that give him the activity's equipment to finish the rest of the questions in 15 minutes. Observe students behaviour while they are doing the activity. Discuss with students for 10 minutes. Be sure all students understand the requirements.
Prepare students for the activity	Ask students to bring the experimental materials one day before implementing the experiment.
Doing the activity	In groups
Extension of the activity in the classroom	For students who have scored less than 2 in the rubric, do not mark their work and give them a chance to improve through home work. This procedure will encourage students to continue to look for improvement in their performance.
Extension of the activity at home	Students who finish the experiment early: give them an extension activity.

Activity M2
The Power of Magnets

Adapted from: Centre, J. G. (1991). *Hands-on science and technology : teaching science and technology in primary classrooms*: Hawthorn East, Vic.; Peters, J., & Gega, P. (2002). *Science in Elementary Education* (9th Edition ed.): Merrill Prentiee Hall, New Jersey Columbus, Ohio.

Student Sheet

NAME:.. SCHOOL ....

Your teacher will assess your work according to these criteria

Rubric

coring Criteria	1	2	3	4
Student drew his hypotheses about the strength of magnets				
Student recorded the steps for implementing experiment				
Student conducted an experiment				
Student inferred which are the strongest parts of the magnet				
Student determined which kind of magnet is the strongest				
Total Score				

Scoring Key

4 points	correct, complete, detailed
3 points	partially correct, complete, detailed
2 points	partially correct, partially complete, lacks some detail
1 point	incorrect or incomplete, needs assistance

Comments:
……………………………………………………………………………………………
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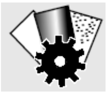
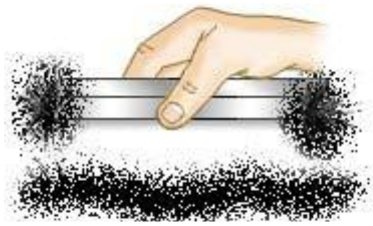
Activity M2

Some people say they can tell how strong a magnet is just by looking at it. What do you think? How can you find out the power of a magnet?

Part1:

 Materials: Bar magnets, pins



Procedures:
Spread pins on a magnet.
Raise the bar magnets from the middle.

Answer these questions
How are the pins collected around the magnet?

....
....

Which part of a magnet is the strongest? The weakest?

....
....

Give an explanation for what you see

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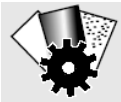
Part 2:

Keys were dropped into a pool and landed in a small place at the bottom of the pool, where you cannot use a magnet to touch the keys directly. If you have three kinds of magnets, which one do you think is the best to get the keys out?

To solve this problem first do this experiment to help you:

 Materials

Several different kinds of magnets

Two small pieces cut from a straw, Pencil , Sheet of lined paper and Paper clips

Procedures

Put a paper clip on two pieces of soda straw, placed on a sheet of lined paper.

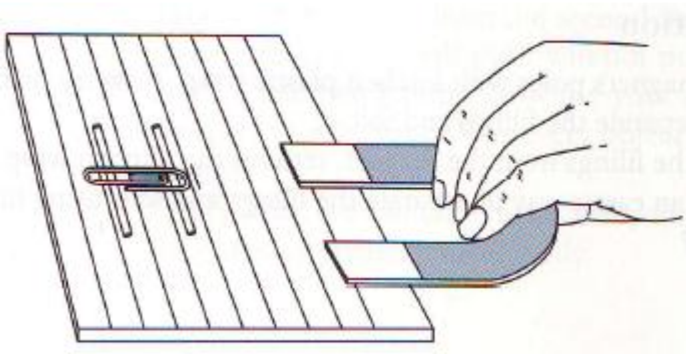
Make a pencil mark at the front of the clip.

Line up an end (pole) of magnet with the clip as shown.

Slowly bring the magnet near the paper clip.

Stop moving the magnet when the clip moves.

Count the lines between the pencil mark and magnet.



Answer these questions:

Test several magnets. Which is the most powerful? Can you put them in order from weakest to strongest?

....

....

Are both ends (poles) of a magnet equally powerful? How can you find out?

....

....

Now, based on your experiment, which kind of magnet is the strongest? Can you use it to pick up the keys and why?

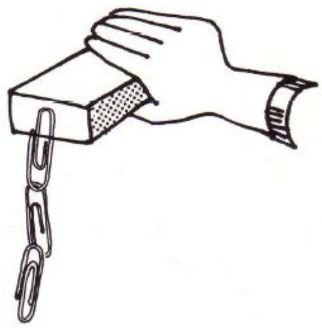
....

....

Activity M2
Extension

Can you measure the strength of our magnets another way?

Explain how

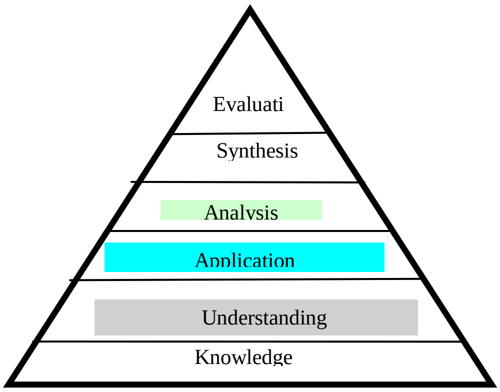


Student Self-Assessment

Put (√) under the number you think represents your performance. For example, if you think you completely followed the instructions, put (√) under (4), if you think you followed most instructions put (√) under (3). So, (4) means the highest mark and (1) the lowest.

Item	1	2	3	4
I wrote a hypothesis for how the magnet power is distributed between its parts.				
I discussed with my group how we conducted the experiment and recorded the steps as required.				
I can determine where the magnet power is concentrated.				.
I did Part 2 of the experiment.				
I measured the power of the magnets and determined the strongest one.				

Activity M2
Teacher Sheet

Essential skills	**Focus Essential Learning** 1. Knowledge & thinking ▪ observation ▪ prediction ▪ experimentation ▪ inference 2. The Content of Essential Learning Students should be able to: ▪ Deduce that magnets have two different poles. ▪ Measure the power of magnets. ▪ Compare between the power of different kinds of magnets  **Supporting Essential Learning** ▪ Develop interest and enthusiasm toward exploring and investigating magnetism. Develop an interest in and enthusiasm for investigating the concept of magnetism.
Guiding the activity	Divide the students into teams of four. Distribute copies of Activity Sheet to each student. Distribute the equipment to each team.
Activity description	Part1: Q1: the pins collected around the magnet poles. Q2: the poles are the strongest parts of a magnet and the middle the weakest. Q3. there are variety of answers for these questions, however some students may describe how the pins are collected around the magnet and others may be drawing what they observe or explaining it. Part2: Q1: depends on the kind of magnets. Q2: yes, it can be observed by examining each end of a magnet at an equivalent distance from a paper clip. Extension: student can measure the power of a magnet by placing a paper clip on one end of each magnet and adding another paper clip to this one, so that they both hang down like a chain, so the power of each magnet is the average number of paper clips that it can hold.
Rubric	Any student who has less than 4 in the rubric, do not mark his work and give him a chance to improve through home work. This procedure will encourage students to continue to look for improvement in their performance.
Extension of the activity	Students who finish the experiment early: give them extension activities.

Activity M3
Magnet poles
Adapted from: Peters, J., & Gega, P. (2002). *Science in Elementary Education* (9th Edition ed.): Merrill Prentiee Hall, New Jersey Columbus, Ohio.

Student Sheet

Name.. School ....

Your teacher will assess your work according to these criteria

Rubric

Scoring criteria	4	3	3	1
Wrote hypotheses				
Draw a plan to test the hypotheses				
Described his observations.				
Inferred two characteristics of magnets				
Named the magnet poles				
Total				

Scoring Key
4 points correct, complete, detailed
3 points partially correct, complete, detailed
2 points partially correct, partially complete, lacks some detail
1 point incorrect or incomplete, needs assistance

Teacher Comments:

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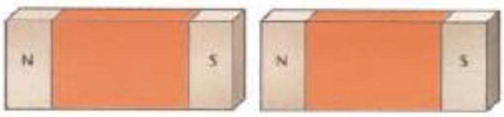
Activity M3
Magnet poles

Invitation

A magnet usually has two ends, called poles. Is this activity you will conduct experiment to discover some characteristics of magnets.
In this activity you will discover:
The differences or similarity between the magnet poles.
The reason of named the poles of magnet.

Equipment
2 similar bar magnets
Materials: holder, a bar of magnet, string, (north, south, east, west signs).



East
North South
West

Hypotheses
The ends of a magnet are …………………..…… (Similar, different).
The ends of a magnet, if put in a free position direct to the ………………………. (North- South, East-West).

Discuss your hypotheses with your group and design plan to investigate them

Write your plan:
....
....
....
.

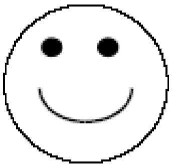
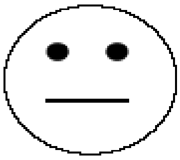
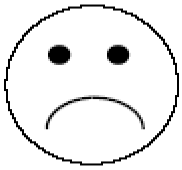
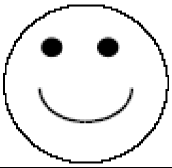
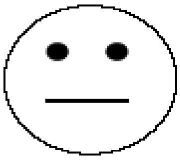
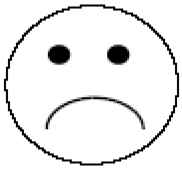
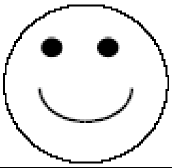
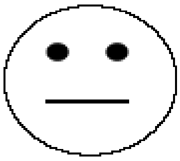
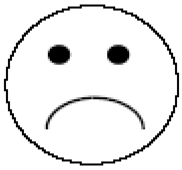
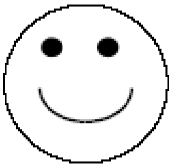
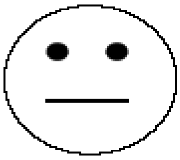
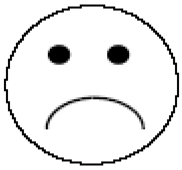
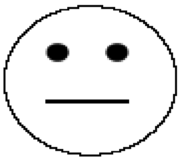
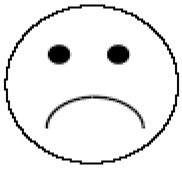
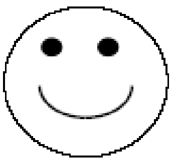
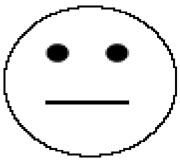
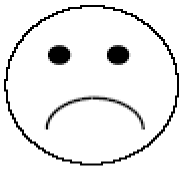
Record your observation
....
....
....

If the end of a magnet is called a pole, name the ends of a magnet according to their directions ....

Summarise the result of your experiment.

....
....
....
....
....

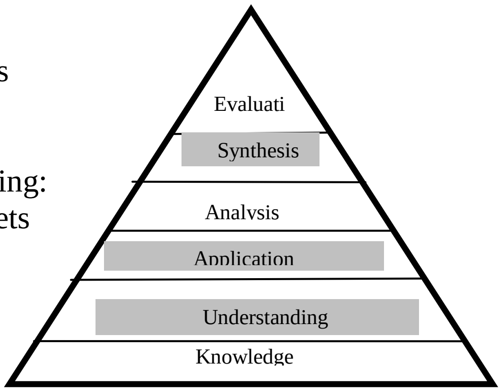
Student Self-Assessment

I made hypotheses			
I discussed with my group the problem.			
I wrote a plan to help me to do investigation.			
I worked cooperatively with my group.			
I asked my teachers when I had difficulty.			
I feel about this activity.			

If I could continue working in this activity I would try to understand:
....
....
....

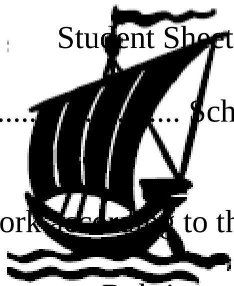
What I learned in this activity is:
....
....
....
....

Activity M3
Teacher Sheet

Essential Learning	**Focus Essential Learning** 1. Knowledge and thinking ▪ Problem solving- skills ▪ Experiment ▪ Inferring 2. Content of Essential Learning: ▪ Understand that magnets contain two opposite poles. ▪ Name the magnet poles.  **Supporting Essential Learning** ▪ Develop interest and enthusiasm toward draw hypotheses and test them**.** ▪ Embrace the scientific method adopted in the study of natural phenomena
Time	20-30 minutes
Activity description	In this activity students will write hypotheses to investigate whether the magnet poles are different, and also discover the direction of a magnet when put in a free position in order to deduce the names of magnet poles.
Doing the activity	In groups
Rubric	It is supposed that your assessment against the rubric and student assessment would give you a clear feedback about student needs.
Extension of the activity at home	As you observe your students while they are working and assist them when they need, you would obtain some idea about students' progress. So, assessment of student work against the rubric will be easier. Any student who has less than 2 in the rubric, do not mark his work and give him a chance to complete his activity at home. If they showed a low level of achievement give them extension homework. This procedure will encourage students to continue to look for improvement in their performance.

Activity M4
Compass

Adapted from : Aldridge, B., Croven, J., and Hunter, C.(1996), Teacher Materials: Learning Sequence Item:945 Magnetism, Scope, Sequence & Coordination. A national Curriculum Development and Evaluation Project for High School Science Education, http://dev.nsta.org/ssc/pdf/v4-0945s.pdf



Student Sheet

Name:.. School ....

Your teacher will assess your work according to these criteria

Rubric

Criteria	1	2	3	4
Determined the problem				
Provided a method to solve the problem				
Described the procedures for solving the problem				
His solution was				
The total scores				

Scoring Key

4 points	correct, complete, detailed
3 points	partially correct, complete, detailed
2 points	partially correct, partially complete, lacks some detail
1 point	incorrect or incomplete, needs assistance

Teacher Comments:
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Activity M4
Compass

A number of seamen lost their way in the sea while they were fishing. All what they need is to find north to find up the back way. As you are science student, how can you help them to find north?

Materials that may need are: bar magnets, a small piece of cork, container filled with water, glass quart jar, pencil, thread (you may not need to use all materials at once).

Discuss the problem with your group and design a plan by using magnets.

The problem is:

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Our plan is (you can draw):

Implement your plan. (Use Experiment Form Sheet)

Experiment Form

Scientist

Title of Activity:

Observation: What caused you to ask the question?

Question: What do you want to find out?

Hypothesis: What do you think you will find out?

Procedure: How will you find out? (List step by step. Use the back of this page if necessary)

1.
2.
3.
4.

Result(s): What actually happened?

Conclusion(s): What did you learn?

Extension Activity M4

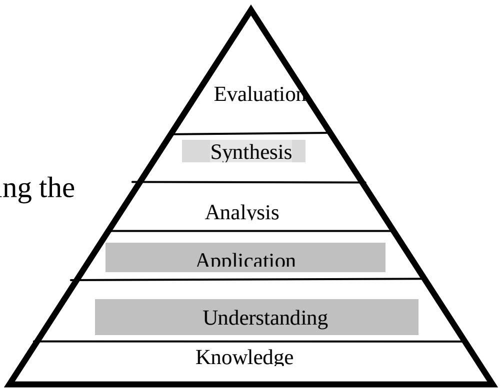
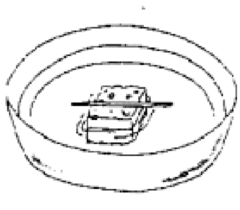
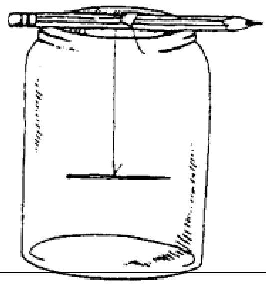
By using some materials from the last activity try to find another solution

Student Self-Assessment

Circle the number you think represents your performance or opinion about this activity (for example if you think the problem is easy put a circle around number 4, or circle number 3 if you think it is somewhat easy. If you think it is difficult, circle number 1)

I do not understand the problem	1 2 3 4	I can explain this problem
I cannot recognise the important and unimportant parts of this problem	1 2 3 4	I can recognise the important and unimportant parts of the problem
I do not know where to start	1 2 3 4	I can solve the problem & explain the solution
This was a difficult problem	1 2 3 4	This was an easy problem

Activity M4
Teacher Sheet

Essential Learning	**Focus Essential Learning** 1. Knowledge and thinking ▪ problem –solving skills 2. Content of Essential Learning: Students should be able to: ▪ Make a compass. ▪ Find the direction of North by using the compass. ▪ Explain the purpose of using a compass. **Supporting Essential Learning** ▪ evaluate the importance of the practical applications of magnets 
Time	20-35 minutes
Students' background	Historically, the Chinese exhibited interest in the phenomena and behaviour of magnets during the ancient ages. Chinese literature makes reference to the magnetic behaviour of lodestone or magnetite, an iron ore. It was said that a Chinese general initially used a piece of lodestone as a compass. Lodestone was found to always point in a north-south direction if allowed to freely rotate. The Chinese used this knowledge to produce an early form of the compass. Primitive compasses became more accurate with the application of a magnetic compass needle balancing on a pivot for free rotation in a northward orientation. This orientation is due to the presence of magnetic fields surrounding the earth. A magnetic needle on a compass will align itself with these magnetic lines of force. The proficient knowledge and use of a modern compass is very valuable. Such knowledge and use enable one to find his or her way without roads or noted trail. Compass use can also open more paths of enjoyment outdoors!
Activity description	In this activity students will try to solve a problem by making a compass. Students can use the materials that they have to make a compass in different ways such as those shown in the following figures:  
Doing the activity	In groups
Extension of the activity at home	As you observe your students while they are working and assist them when necessary, you would obtain some idea about students' progress. So, assessment of students' work against the rubric will be easier. Students who have scored less than 2 in the rubric, do not mark their work and give them a chance to complete their activity at home. If they showed a low level of achievement give them a homework extension task. This procedure will encourage students to continue to look for improvement in their performance and be more serious about accomplishing their work.

Activity 5
Electromagnet

Adapted from: Arevalo, R., Bortz, A., & Tse, T. (2003). *Electromagnetism*, from www-2.cs.cmu.edu/People/rapidproto/students/abortz/project3/handout.pdf; Office of Science & Math Education (n.d.), *Get A Charge*: Illinois State Board of Education, from www.sciencemadesimple.com; Centre, J. G. (1991). *Hands-on science and technology: teaching science and technology in primary classrooms*: Hawthorn East, Vic.

Student sheet

NAME:... SCHOOL ....

Your teacher will assess your work according to these criteria

Rubric

Excellent	Very good	Good	Needs to improve
Correctly answered all questions. Accurately wrote the experiment report.	Correctly answered most questions. Accurately predicted and tested the materials with a magnet. Made few errors classifying objects that are and are not attracted by magnets. Illustrated what was observed.	Correctly answered some questions. Had difficulty predicting and testing the materials with a magnet. Made many errors classifying objects that are and are not attracted by magnets. Provided some relevant illustration for what was observed.	Answers may be totally incorrect or irrelevant. Blank/ no response.

Teacher Comments:
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Activity 5
Electromagnet

Invitation

Magnets can be made by different ways.

In this activity you will find out how a magnet can be made in two ways, one by electricity, which is called an electromagnet, and another by a magnet.

Part 1: making an electromagnet.
Materials
6-volt battery
Long iron nail
36 inches of insulated, 18-gauge wire
Box of paper clips
Procedures:
1) Wrap the insulated wire around the nail as tightly as possible. Make sure the two ends of the wire are visible.
2) Attach one alligator clip to each of the wires that are coming out of the battery holder.
3) Attach the other ends of the alligator clip to the two ends of the wire from the nail.

Describe your observation:

4) See how many paper clips you can pick up.

Part 2:
Suppose you just have an iron nail and a magnet. With these materials, how can you make a magnet?
Exploration
1. Get a large iron nail. Touch it to some steel pins to see if it attracts them.
2. Put one end of the magnet on the nail near the head.
3. Stroke the whole nail with the magnet 20 times. Stroke in one direction only, (as illustrated).
4. Touch the nail again to some pins. How many pins does the pin attract?
Record this number

1. How much stronger can you make your nail magnet? How many pins does it attract after 30 strokes? 40 strokes? Record how many pins are attracted each time.

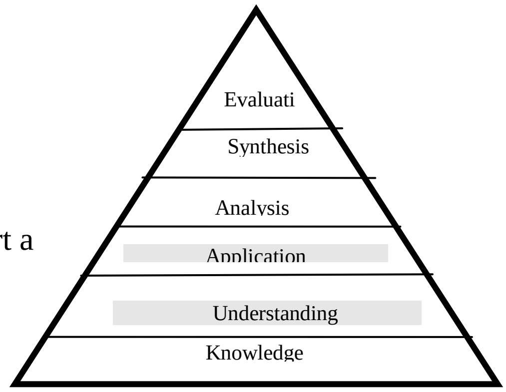
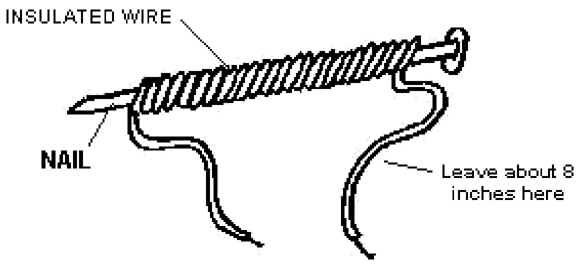
2. Test the other nail to see if it attracts pins. If it does not, stroke this nail back and forth, instead of just one way.
How strong is the magnet after 20 strokes? 30strokes? 40 strokes?

4. Suppose you stroke a small steel screwdriver one way with a magnet.
How many pins will it attract after 20 strokes?

Activity 5
Electromagnet
Extension Activity

How can you make the electromagnet stronger?

Activity M5
Teacher Sheet

Essential Learning	**Focus Essential** 1. Knowledge and thinking ▪ Experiment ▪ Observation ▪ Write report 2. Content of Essential Learning: ▪ Make a temporary magnet ▪ Explain two ways to convert a pin to a magnet **Supporting Essential** ▪ Develop interest and enthusiasm toward conducting an experiment and reporting the result 
Time	20-30 minutes
Activity description	Part1: give each pair of students one battery, iron nail, 40" copper wire, and about 30 paper clips. Have them, using only the nail. Try to pick up as many paper clips as possible. Discuss methods and results. Then instruct them to wrap the copper wire around the nail ten times leaving 5-6 inches of wire free on each end of the nail. Attach one end of the wire to the negative pole of the battery. Tape securely and then touch the other end of the wire to the positive pole of the battery while their partner uses the nail to pick up paper clips.  Then release the wire from the positive pole of the battery. Discuss methods and results. Record the number of paper clips picked up by the magnetized nail. Part 2: in this part each pair of students will magnetize an iron by stroking it with a magnet. Students should follow instructions.
Doing the activity	In pairs
Rubric	It is supposed that your assessment against the rubric and student assessment would give you a clear feedback about student needs.
Extension of the activity at home	As you observe your students while they are working and assist them when necessary, you would obtain some idea about students' progress. So, assessment of students work against the rubric will be easier. Any student who has less than 2 in the rubric, do not mark his work and give him a chance to complete the activity at home. If they showed a low level of achievement give them extension homework. This procedure will encourage students to continue to look for improvement in their performance and be more serious for accomplishing their work.

Activity M6
Magnetic Force Field
Student sheet

NAME:... SCHOOL ....

Your teacher will assess your work according to these criteria

Rubric

Excellent	Very good	Good	Needs to improve
Answered all questions correctly. Drew clearly the magnetic field. Determined accurately the right places of the collected iron filings. Inferred the names of magnet poles for all blanks. Presented a correct definition of the magnet field.	Answered most questions correctly. Drew relatively a clear magnetic field. Determined accurately the right places of the collected iron filings. Inferred at least one of the names of magnet poles for most blanks. Presented a correct definition of the magnet field.	Answered few questions correctly. Drew with some errors the magnetic field. Determined to some extent the right places of the collected iron filings. Inferred the names of magnet poles for some blanks. Presented a definition of the magnet field with some errors.	Answers may be totally incorrect or irrelevant. Blank/ no response

Teacher Comments:
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Activity M6
Magnetic Force Field

Have you noticed that a magnet attracts some materials without touch them? Do you know why?
You will discover by yourself the answer during doing this activity

Things You Will Need:
Iron filings, bar and U-shaped magnets
Three sheets of notebook paper
Paper cup
Do This:
Collect the iron filings into a paper cup.
Place round, bar-shaped and U-shaped magnets on a table and cover each with a sheet of notebook paper.
Observe the patterns formed by the magnets.

To which area of the bar magnet are the iron filings pulled? Why?

Draw a diagram of a magnet and its field

(1) the bar	(2) the U shaped

In which area do the iron filings collect more? Why?

Repeat what you did with the U-shaped magnet and draw your observation in rectangle (2).

Repeat the same experiment using 2 magnetic bars, and according to your observation infer the names of the magnetic poles in the blanks (use N for north, and S for south)

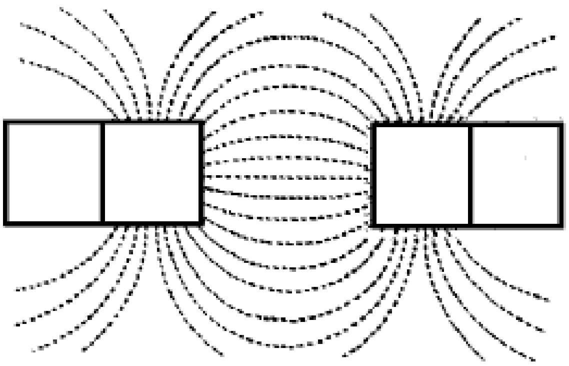

Figure (1)

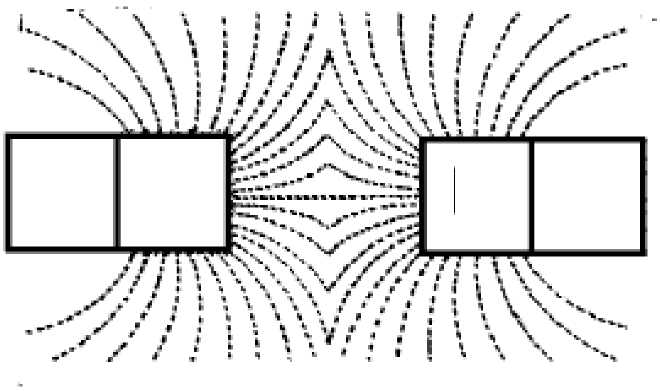

Figure (2)

What is the magnetic field?

....

....

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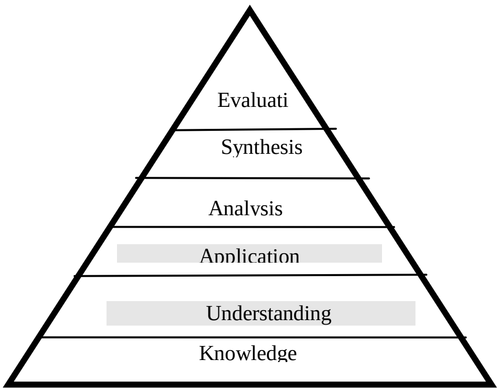
Activity M6
Teacher Sheet

Essential Learning	**Focus Essential Learning** 1. Knowledge and thinking ▪ Experiment ▪ Observation ▪ Drawing 2. Content of Essential Learning: ▪ Draw the magnetic field ▪ Describe the magnetic field **Supporting Essential Learning** ▪ Develop interest and enthusiasm toward discovering the characteristics of magnets 
Time	30-40 minutes
Description of the activity	In this activity students will conduct an experiment using two types of magnets; the bar and U-shaped magnet, and Iron filings. After observing the magnetic field students should draw it as has been illustrated in a student's sheet. The Figure (1) illustrates similar magnetic poles, and figure (2) shows different magnetic poles.
Doing the activity	▪ Divide students into groups. ▪ Distribute activity sheets. ▪ Ask each group to follow the instructions for the activity. ▪ When the magnetic field clearly appears, ask students to draw it for each type of magnets. ▪ Give students some time to discuss their results. ▪ Discuss with them their answers in the rest of time.
Doing the activity	In groups
Rubric	It is supposed that your assessment against the rubric and student assessment would give you clear feedback about student needs.
Extension the activity at home	As you observe your students while they are working and assist them when necessary, you would obtain some idea about students' progress. So, assessment of students work against the rubric will be easier. Any student who has less than 2 in the rubric, do not mark his work and give him a chance to complete the activity at home. If they showed a low level of achievement give them extension homework. This procedure will encourage students to continue to look for improvement in their performance and be more serious for accomplishing their work.

Task 1
Magnets

Adapted from: Magnet, Chapter1, Students Achievement on The Performance Assessment Tasks, TIMSS,1995, http://timss.bc.edu/timss1995i/TIMSSPDF/PAchap1a.pdf

Material:

- 6 steel balls
- 6 paper clips
- 6 poker chips
- 10 washers
- 2 magnets
- A 30 cm ruler

Your task:

Use the materials to find which magnet, A or B, is stronger

This is what you should do:
Test the magnets in at least two different ways.

1. I found that magnet ………………………….is stronger

2. Describe 2 different ways you used to find which magnet was stronger. You can draw pictures as part of your answer if it helps you to explain

	What I did	**What happened**
Test One **Magnet A** **Magnet B**		
Test Two **Magnet A** **Magnet B**		

Magnet
Task 1
Teacher Sheet

Criteria for correct response

Item 1 - Identify stronger magnet. Correct magnet identified according to administrator's notes.

Total Possible Points: 2

Item 2 – Describe two tests used to identify stronger magnet.

i) Records what he did with each magnet in both tests.

ii) Relates results of each test to the identification of the stronger magnet. (Note: Student score reflects that at least one correct test is described.). *Total Possible Points: 2*

Total Possible Scores : 4

Task 2

Magnets

Adapted from: Oregon State Department of Education, http://pals.sri.com/tasks/5-8/Magnet/directs.html

Materials

- pins
- nails
- bottle caps
- paper
- paper clips
- coins
- other items of various material
- card board
- tacks
- buttons
- various size and shaped magnets
- tag board
- Scales

Directions

Using the materials given to you in class, your task is to use scientific inquiry to determine if a magnet will attract paper clips through materials.

You need to conduct your scientific investigation using the materials in our classroom. As you design your investigation, think about:

Which factors will you vary in your study? Which will you keep the same?

How can you be sure that the distance between the magnet and paper clips is even and constant?

2. List, in order, the steps you will use. You may include a diagram to help illustrate your plans for the investigation. Include any safety procedures you would follow. Make your procedure detailed enough, so someone else could follow it easily.

3. Construct a data table or chart to record your observations and results.

4. Perform the investigation by following the steps outlined in your procedure. Be sure to note any changes to your listed procedures and tell why.

5. Record your observations and measurements. Write statements or paragraphs and/or use tables where appropriate. Now transform your data into a graph.

6. Write an interpretation and analysis of your results.

Task 2
Rubric

	Framing the Investigation, Collecting and Presenting Data	**Designing the Investigation, analysing and interpreting Results**
4	Expresses a clear question and/or hypothesis with advanced support for thinking. Records accurate data and/or observations consistent with complex procedures. Designs a data table (or other format) for observations and/or measurements which is efficient, organized and uses appropriate units. Transforms data into a student-selected format(s) which is most appropriate to clarify results.	Presents a practical design appropriate for answering the question or testing the hypothesis with evidence of recognition of some important variables. Reports results and identifies simple relationships (e.g., connecting one variable to another). Explicitly uses results to address the question or hypothesis and illustrate simple relationships. Not Applicable
3	Expresses a clear question and/or hypothesis with detailed support for thinking. Records accurate data and/or observations completely consistent with the planned procedure. Designs a data table (or other format) for observations and/or measurements which is organized and uses appropriate units. Transforms data into a student-selected format(s) which is complete and useful.	Presents a practical design for an investigation which addresses the question or hypothesis and attempts to provide a fair test. Reports results accurately and identifies obvious patterns (e.g., noting a pattern of change for one variable). Explicitly uses results to address the question or hypothesis. Not Applicable
2	Expresses a question and/or hypothesis with some support for thinking. Records reasonable and sufficient data and/or observations generally consistent with the planned procedure. Designs a data table (or other format) useful for recording measurements or observations. Transforms data (e.g., graphs, averages, percentages, diagrams, tables) with teacher support and with minimal errors.	Presents a practical plan for an investigation which substantially addresses the question or hypothesis Summarizes results accurately. Responds to the question or hypothesis with some support from results. Not Applicable
1	Expresses a question and/or hypothesis which is not supported. Records reasonable data and/or observations consistent with the planned procedure, with some obvious errors Designs a data table (or other format) which is inadequate for recording measurements of observations. Does not transforms data into a teacher-recommended format.	Presents a practical plan related to the topic which minimally addresses the question or hypothesis. Summarizes results incompletely or in a misleading way. Responds to the question or hypothesis without support from the results. Not Applicable
0	Does not express the purpose of the investigation as either a question or a hypothesis. Records data and/or observations unrelated to the planned procedure. Does not correctly use a teacher supplied data table. Not Applicable.	Presents a plan which is impractical or unrelated to the topic. Omits results in summary. Does not respond to the question or hypothesis. Not Applicable

Appendix B
Performance Assessment Program
Part (2)

Workshops
On
Performance-based assessment program

Purposes of workshops

After these workshops teachers are expected to

1. Define both traditional and alternative assessment and distinguish between them.
2. Appreciate performance-based assessment as an essential element to reform assessment practices.
3. Integrate assessment producers with science curriculum and instruction.
4. Design lesson plan in science based on performance assessment.
5. Select and use different assessment strategies.
6. Design and implement activities and tasks that require higher order thinking by using inquiry and problem-solving.
7. Be able to use different methods to assess students' performance.
8. Administer classroom effectively.
9. Consider individual differences between students.
10. Use observation strategies for assessment purposes.

Workshops

There are eight workshops involved; each one contains the purposes of the workshop, and four activities that the trainees are required to accomplish within a specific time.

Workshop period: 8 days.

The following table is showing the workshops and their time

Workshops	Time/min.
1. Introduction	230
2. Requirements of implementation of performance-based assessment	230
3. Designing and adapting activities for the electricity unit.	230
4. Designing and adapting assessment tasks	230
5. Designing and adapting portfolios and projects	230
6. Designing and adapting activities for magnets unit	230
7. Cooperative Groups	180
8. Evaluating the difficulties of implementation of PBAP	230

The target group:

Science teachers in the experimental schools who are teaching the experimental classrooms from Grade 6.

Working Methodology:

In groups from (3-5) teachers. They discuss the posed theme within the group and then present their work to other groups and make amendments.

Workshop (1)

Introduction

After this workshops teachers are expected to

1. Have a general idea about the Performance-Based Assessment Program
2. determine some important disadvantages of traditional assessment methods
3. define performance-based assessment and describe some of its characteristics

Activity No.	Title	Time/min.
(1)	Determining disadvantages of traditional assessment methods	60
(2)	Taking notes and posing questions about presenting the assessment program	60
(3)	Describing performance-based assessment	60
(4)	Naming types of performance-based assessment	50

Activity (1-1)

You will listen to a presentation about the performance-based assessment program. You can take some notes and ask questions after it.

Appendix (1-2)

Presentation about performance-based assessment.

Activity (1-2)

Read the article (Appendix1-1) and then complete the following with your group:

- Discuss the article.
- Summarise the main idea in points.
- Add your own points on the issue.
- Present the work to other groups.

Appendix (1-1)

The disadvantages of traditional assessment (Al-Dossary,2000, Handbook for Educational evaluation, pp. 141-145).

Activity (1-3)

In cooperation with your group:

- Define performance-based assessment
- Discuss the most important features of performance assessment.

Appendix (1-3)

The Introduction of the Performance-Based Assessment Program.

Activity (1-4)

Name and describe some forms of performance assessment

Appendix (1-4)

The Introduction of the Performance-Based Assessment Program.

Workshop (2)

Requirements of the implementation of performance-based assessment

After this workshop teachers are expected to:

1. Be able to use many forms of classroom assessment forms in order to combine assessment with other learning components.
2. Recognise the advantages of the use of the constructivist approach for learning and teaching purposes.
3. Use new teaching styles.
4. Utilise performance assessment for formative purposes.

Activity No.	Title	Time/min.
(1)	Integrating assessment with teaching and curriculum	60
(2)	Embracing the constructivist approach	60
(3)	Implementing new teaching styles	60
(4)	Using assessment for formative purposes	50

Activity (2-1)

Integrating assessment and teaching with curriculum has become the main characteristic of modern education. In groups, discuss how you can integrate assessment with teaching and curriculum.

Appendix (2-1)

The Introduction of Performance-Based Assessment Program; Toolkit98, Chapter 2-integrating Assessment with Instruction (http://www.nwrel.org/assessment/toolkit98/chapter2.html)

Activity (2-2)

Teaching and learning have gained essential benefits from implementing constructivist principles. In groups, read Appendix (2-2) about constructive theory and suggest approach explains how it can be used in the classroom.

Appendix (2-2)

The Introduction of Performance-Based Assessment Program.

Activity (2-3)

Suppose that you are in a training group that trains new teachers to use teaching styles focusing on teaching higher-order thinking. In the first stage of the training program you will train them in how they can use problem-solving and inquiry styles, including defining each style, distinguishing between them and developing strategies for using them.

Appendix (2-3)

The Introduction of Performance-Based Assessment Program.

Activity (2-4)

Assessment can be used for two purposes: sumative or formative. Sumative means using assessment to grade students, but what does formative assessment mean? How can it be used? What are its advantages?

Appendix (2-4)

The Introduction of Performance-Based Assessment Program.

Workshop (3)

Designing and adapting assessment tasks for Unit 9

After this workshop teachers are expected to be able to:

1. Design or choose a performance assessment activity according to particular criteria.
2. Adapt a performance assessment activity to the classroom.
3. Effectively implement a performance assessment activity in the classroom.
4. Prepare suitable extension activities for both low and high-achieving students.

Activity No.	Title	Time/min.
(1)	Preparing and planning for implementing the electricity assessment activity (1)	60
(2)	Preparing and planning for implementing the assessment activity (2)	60
(3)	Preparing and planning for implementing the assessment activity (3)	60
(4)	Preparing and planning for implementing the assessment activity (4)	50

Activity (3-1)

A. Review the electricity activity (1) according to:

- The criteria of designing or choosing an appropriate performance assessment activity.
- How the activity suits your classroom in terms of time, place, and materials.

B. Design an extension activity and homework for both low and high-achieving students.

C. Create a form for observing students while they are working on the activity.

Appendix (3-1)

Units of work, electricity, activity (1)

Activity (3-2)

A. Review the electricity activity (2) according to:

- The criteria of designing or choosing an appropriate performance assessment activity.
- How the activity suits your classroom in terms of the time, a place, and materials.

B. Design an extension activity and homework for both low and high-achievement students.

C. Prepare a method for students to work in groups.

Appendix (3-2)

Units of work, electricity, activity (2)

Activity (3-3)

A. Review the electricity activity (3) according to:

- The criteria of designing or choosing an appropriate performance assessment activity.
- Suit the activity your classroom in terms of the time, a place, and materials.

B. design an extension activity and homework for both low and high-achievement students.

C. develop a method for correcting student work.

Appendix (3-3)

Units of work, electricity, activity (3)

Activity (3-4)

A. review the electricity activity (3) according to:

- The criteria of designing or choosing an appropriate performance assessment activity.
- How the activity suits your classroom in terms of the time, a place, and materials.

B. Design an extension activity and homework for both low and high-achievement students.

Appendix (3-4)

Units of work, electricity, activity (4)

Workshop (4)

Designing and adapting assessment tasks

After this workshop teachers are expected to be able to:

1. Design or choose performance assessment activities and tasks according to particular criteria.
2. Adapt performance assessment activities and tasks to his classroom.
3. Effectively implement performance assessment activity in the classroom.
4. Prepare suitable extension activities for both low and high-achieving students.

Activity No.	Title	Time/min.
(1)	Preparing and planning for implementing the electricity assessment activity (5)	60
(2)	Preparing and planning for implementing the assessment activity (6)	60
(3)	Preparing and planning for implementing the assessment task(1)	60
(4)	Preparing and planning for implementing the assessment tasks (2)	50

Activity (4-1)

A. Review the electricity activity (5) according to:

- The criteria of designing or choosing an appropriate performance assessment activity.
- How the activity suits your classroom in terms of the time, a place, and materials.
- Design an extension activity and homework for both low and high-achievement students.
- Develop a method for recording students’ performance each week.

Appendix (4-1)

Units of work, electricity, activity (5)

Activity (4-2)

A. Review the electricity activity (6) according to:

- The criteria of designing or choosing an appropriate performance assessment activity.
- How the activity suits your classroom in terms of the time, a place, and materials.

B. Design an extension activity and homework for both low and high-achievement students.

Appendix (4-2)

Units of work, electricity, activity (6)

Activity (4-3)

The assessment task is similar to somewhat the end unit test. However, the most important feature of the assessment task is the availability of the use it for learning. In groups, discuss the implementation of the electricity task (1) in the classroom.

Appendix (4-3)

Electricity task (1)

Activity (4-4)

In groups, review the electricity assessment task (2).

Appendix (4-4)

Electricity task (1)

Workshop (5)

Designing and adapting portfolios and projects

After this workshop teachers are expected to be able to:

1. Design and implement a portfolio.
2. Plan and design for implementing projects.
3. Design a method for classroom observation.
4. Suggest different forms of a student self-assessment.

Activity No.	Title	Time/min.
(1)	Preparing and planning for implementing the portfolio	60
(2)	Preparing and planning for implementing projects.	60
(3)	Planning an observation method	60
(4)	Designing self-assessment forms	50

Activity (5-1)

A portfolio is more than a file where students' work is kept, it can be used effectively for many purposes. In a group, discuss the purpose of the use of portfolios and develop a method for using them with your students. This method should include:

- What kind of work may be put in the portfolio?
- Where the portfolios should be kept?
- How portfolios can be corrected?

Appendix (5-1)

The Introduction of Performance-Based Assessment Program.

Activity (5-2)

A project is innovative work; it gives students the opportunity to use their entire ability without obstacles. For the electricity unit, three projects were designed, discuss them in groups in terms of:

- Follow up students over the project time.
- Design a rubric to correct them.
- The opportunity for students to present their work.

Appendix (5-2)

The Introduction of Performance-Based Assessment Program.

Activity (5-3)

A considerable part of student behaviour cannot be assessed directly by assessment tools, which force teachers to use various methods of observation to collect data about students' behaviour. In this activity develop a plan for using observation in the classroom, which involves:

- An observation form for recording data.
- Observation techniques (what kind of behaviour you have to observe, how you record your observations, how to combine observation data with others).

Appendix (5-3)

The Introduction of Performance-Based Assessment Program.

Activity (5-4)

Self-assessment is a main part of an alternative assessment, so teachers should consider how can be used by students. As a group, review the self-assessment forms in appendix (5-4) and answer these questions:

- Which one of these forms is appropriate for using with your students? If there is none, design a new one.

- What is the method that you can suggest to train students to use self-assessment?
- Reorder the forms in order to start the students with the simplest one.

Appendix (5-4)

The Introduction of Performance-Based Assessment Program.

Workshop (6)

Designing and adapting assessment tasks for unit 10

After this workshop teachers are expected to be able to:

1. Design or choose a performance assessment activity for unit 10 according to particular criteria.
2. Adapt a performance assessment activity to the classroom.
3. Effectively implement a performance assessment activity in the classroom.
4. Prepare suitable extension activities for both low and high-achieving students.

Activity No.	Title	Time/min.
(1)	Preparing and planning for implementing magnets assessment activity (1,2)	60
(2)	Preparing and planning for implementing magnets assessment activity (3,4)	60
(3)	Preparing and planning for implementing magnets assessment activity (5,6)	60
(4)	Preparing projects	50

Activity

A. Review the magnets activity (1-6) according to:
   - The criteria of designing or choosing an appropriate performance assessment activity.
   - How the activity suits your classroom in terms of the time, place, and materials.
   - Design an extension activity and homework for both low and high-achieving students.
   - Suggest some projects for this unit.

Appendix

Units of work, magnets unit, activity (1-6)

Workshop (7)

Cooperative Groups

After this workshop teachers are expected to be able to:

1. Understand the aims of the use of group work
2. Be able to design different strategies for cooperative learning

Activity No.	Title	Time/min.
(1)	Group work	60
(2)	Cooperative learning	60
(3)	Strategies of cooperative learning	60

Activity (7-1)

Group work occurs when two students or more work together. In a group, discuss some features of group work.

Appendix (7-1)

Killen (2003), Effective Teaching Strategies, third edition, Social Science Press, Australia.

Activity (7-2)

“Cooperative learning is not so much learning to cooperate as it is cooperating to learn” (Wong & wong, 1998 cited in Killen,2003, p. 147). In a group, explain this statement?

Appendix (7-2)

Killen (2003), Effective Teaching Strategies, third edition, Social Science Press, Australia.

Activity (7-3)

"Co-operative learning is an effective method for having students achieve a wide range academic and social outcomes including enhanced achievement, improved self-esteem, positive interpersonal relationships with other students, enhanced time-management skills, and positive attitudes towards Science" (Killen, 2003, p. 151). Suggest with your group a method for using group work to achieve these elements.

Appendix (7-3)

Killen (2003), Effective Teaching Strategies, third edition, Social Science Press, Australia.

Workshop (8)

Evaluating the difficulties of implementation of PBAP

After this workshop teachers are expected to be able to:

1. Suggest some methods for giving students feedback.
2. Evaluate the study project and make plan for its implementation.

Activity No.	Title	Time/time
(1)	Effective teacher feedback	60
(2)	Assessment Program Strategy	60
(3)	Assessment Program Guide	60
(4)	Preparing for first week	50

Activity (8-1)

"You need to study harder", "improve your writing hand"; teachers use such statement to record their evaluating of student performance. But such evaluative feedback may have negative or positive effects on student motivation toward learning. In groups, discuss how feedback statement should be and when a student be should given forward?

Appendix (8-1)

1- Chappuis, S., & Stiggins, R. J. (2002). Classroom Assessment for Learning Classroom Assessment for Learning. *Educational Leadership* (Vol. 60, pp. 40): Association for Supervision & Curriculum Development.

2- Black, P., & William, D. (1998b). Inside the Black Box: Raising Standards Through Classroom Assessment. *Phi Delta Kappa, 80* (2), 139-149.

Activity (8-2)

In groups, discuss the most difficulties you suspect to face over implementing this program, and suggest how can be overcome.

Activity (8-3)

Design a lesson plan from Unit 9 or 10, according to the program strategies .

Activity (8-4)

Prepare the first week work with introduce the program to students.

Appendix C
Performance Assessment Program
Part (3)

PERFORMANCE-BASED ASSESSMENT PROGRAM (PAP)

INTRODUCTION TO PERFORMANCE-BASED ASSESSMENT

The purpose of this assessment program is to improve student learning and instruction. In addition, it also seeks to integrate assessment and instruction with the curriculum. The assessment program offers students the opportunity to demonstrate:

- Knowledge and skills in science.
- The application of scientific knowledge such as designing and implementing experiments.
- Process skills in science, critical thinking, problem solving, observation, measurement, data collection, classification, reasoning, and analysis.
- Understanding in order to explain and predict events in the natural environment.
- Scientific attitudes such as flexibility, curiosity, respect for evidence, and critical reflection.
- The communication of scientific understanding to a range of audiences using appropriate scientific language.
- Self-assessment to assess their own progress.

Science teachers require extensive training in the use of performance-based assessment to achieve these stated purposes. This is accomplished through the components of the Performance-Based Assessment Program: The first component is the *Introduction to Performance-based Assessment* which provides science teachers with the knowledge and skills necessary to effectively use performance-based assessment in the classroom, and a practical component, *Professional Performance Assessment Workshops*.

The third is the *Units of Work Based on the Performance Assessment,* which provides teachers with developed activities and performance-based assessment tasks matched to teaching procedures. These activities and tasks were offered because it was recognised that two weeks of training is insufficient for teachers to adequately learn how to design and develop appropriate performance tasks. Therefore, the training program focuses on the use of performance-based assessment, including suggestions for implementing changes in teaching methods and assessment goals.

The content of the Introduction of Performance-Based Assessment Program is described in detail below:

1. Introduction

Although alternative assessment methods have been created and developed worldwide, particularly relating to science, current classroom assessment practices have remained static and unchanged for an extended period. Despite being regularly informed about new education and assessment practices, it appears the teaching profession rarely implements any of these new methods in the classroom. Thus, if we really believe that schools are essential in shaping the development of society, most of our teaching and assessment practices need to be changed.

Fortunately, educational reform movements in several countries have produced positive improvements in learning outcomes; therefore, this analysis will begin with a review of these achievements. Reform movements assert that students become more involved in their own learning when they are offered the opportunity to be more active. This frequently results in a call for teaching methods and styles that encourage students to be reflective, constructive, and self-regulated learners. Effective learning encourages students to use higher order thinking rather than just memorisation to find solutions, which, in turn, requires performance-based assessment.

This paper provides an examination of the concept of performance-based assessment and the corresponding teaching style based on this framework. The practical methods used in the design, selection, and classroom implementation of performance-based assessment tasks and strategies are discussed as well. Finally, the last section of the paper provides a description of the performance-based assessment program that will be implemented in Grade 6.

2. New Forms of Assessment

Educators have recently focused on teaching the nature and process of science as well as the subject matter (National Committee on Science Education Standards and Assessment [NCSESA],1993, p. 3). This new direction means that assessment strategies must be modified to reflect the new importance of higher order thinking, reasoning, communication, problem solving skills, and the conceptual understanding of subject matter. Simply put, classroom practice needs to shift to using assessment in learning. In this respect, the primary purpose of assessment in science education should be to advance the learning of essential science, as well as to provide useful feedback to teachers and students (Akerson, Morrison, & Mcduffie, 2002; Guy & Wilcox, 2000). Assessment should not be restricted to only testing a student's ability to recount information learned from a textbook. Assessment should be embedded into learning and instruction, rather than be kept as a separate element.

Performance-based assessment is defined as "testing that requires a student to create an answer or a product that demonstrates his or her knowledge or skills" (The Office of Technology Assessment of the U.S. Congress, as cited in Feuer, 1995, pp. 202-203). Educators and researchers argue that classroom-based performance assessment provides the opportunity to:

- Examine the process as well as the product, and represent a full range of learning outcomes by assessing students' writing, products, and behaviour (Danielson, 1997; Shepard et al., 1996).
- Situate tasks in authentic, worthwhile, and/or real-world contexts (Stenmark, 1991).
- Preserve the complexity of content knowledge and skills (Shepard et al., 1996; Shymansky et al., 1997).
- Assess higher order thinking skills and deeper understanding (Firestone, Mayrowtz, & Fairman, 1998).
- Embed assessment in instruction rather than separating it from learning (Stenmark, 1991).
- Apply criterion-referenced assessment approaches based on important learning outcomes rather than norm-reference (Stenmark, as cited in Akerson, Morrison, & Mcduffie, 2002).

3. Performance-based Assessment to Improve Teaching and Learning

Several studies indicate that performance-based assessment is a suitable assessment tool that improves learning outcomes and teaching. Baxter and Glaser (1996) conducted a study to determine the role of performance assessments in making relevant cognitive activity apparent to teachers and students. They observed Grade 5 students (n=31 students) implementing a science performance assessment that required the subjects to verbally communicate their thinking process as they worked. The descriptions of the cognitive activities of the students demonstrated significant dissimilarities between those who think and reason well with their knowledge of the task and those who do not. Awareness of and attention to these types of activities, as researchers hypothesise, can support the development of thinking and reasoning in the elementary science classroom. Baxter and Glaser concluded that performance-based assessment not only supports the development of thinking and reasoning in the classroom, but also provides teachers with feedback that can be used to improve the classroom environment.

Biondi (2001) found similar results in an action research project conducted in a Grade 4 classroom (n=21 students). He found that performance-based assessment provides students with tangible evidence of their work as they analysed their strengths and weaknesses. Similarly, Parker and Gerber (2002) found that performance-based assessment was effective in measuring the knowledge and skills of Grades 5 and 6 science students.

Several studies have confirmed that performance-based assessment is more effective at improving student learning than traditional tests. Kelly and Kahle (1999) found that students who took performance assessment tests were better able to explain their reasoning and conceptions (as cited in Akerson, Morrison, & Mcduffie, 2002). Gray and Sharp (2001) found similar results after studying the performance of 140 Year 6 (aged 10 and 11) primary school students in Scotland. Employing two modes of assessment - a paper-and-pencil test and a performance-based task - their results indicated that students, particularly low-achievers, perform better on the more interactive, practical tasks.

Century (2002) examined the impact of alternative and traditional tests during a two and half month study on two groups of Grade 6 students (n=20 in each classroom). While all of the students received the same lessons through the same teaching methods, one group was assessed using traditional test forms, and the other was subject to performance-based assessment. The study revealed that while traditional testing promotes the retention of concrete cognitive knowledge, alternative assessment yields more psychomotor, cooperative learning, and critical thinking skills. In terms of students' attitudes toward science, Century found no significant difference between the groups. This result may indicate the importance of integrating assessment with teaching, which the study avoided. However, the qualitative analysis did show that the alternative group was more satisfied.

These qualitative results confirmed the findings of an earlier study by (Higuchi, 1993). Higuchi compared students' perspectives and attitudes towards performance-based assessment and traditional tests. He collected data through surveys and in-depth retrospective interviews with more than 800 students from 13 schools. Eight different forms of assessment were employed: each form was composed of two discrete open-ended items and eight discrete multiple-choice items. The results showed that more than half of students who completed the survey, and almost two-thirds of those expressing a performance, found open-ended questions more interesting to solve than multiple-choice questions. Moreover, more than half of students reported trying harder on open-ended problems than on multiple-choice problems. The retrospective interviews showed that approximately 83% of students found open-ended questions more challenging. Higuchi concluded that students considered performance assessments more motivating and interesting than traditional tests, and the procedures used in performance assessment encouraged students to elect higher order cognitive processes or problem solving skills.

Performance-based assessment has also been found to improve teachers' competences, as well as enable them to plan instruction according to student needs (Higuchi, 1993). Guy and Wilcox (2000) developed a performance assessment program for 21 pre-service teachers registered for an elementary science methods course. The program focused on teaching science through inquiry strategies. The teachers prepared for several weeks before the performance assessment was administered in an elementary school with K-5 students. The following factors were measured: how will they score rubric, how will they advocated inquiry, how will they endeavoured to assess inquiry, and how would they implement the teaching standards described in the rubric. The results indicated that teachers considered the assessment task educative, and believed that the performance assessment experience increased confidence in hands-on teaching, as well as amplified consciousness of their teaching strengths and weaknesses.

Mcduffle, Akerson, and Morrison (2003) conducted a study of pre-service teachers (n=25) to assess the effect of designing and implementing science performance assessment tasks in K-8 classrooms based on their understanding of standards-based assessment. The study procedures required one semester to complete; the pre-service teachers were trained in designing and implementing performance assessment tasks. The results indicated that the study group came to understand assessment as a formative process, and were subsequently able to construct a valid conception of the nature of performance assessment. The study also highlighted some areas requiring improvement: First, pre-service teachers lacked the ability to adequately analyse student thinking and to design inquiry-based science instruction. Second, the teachers also appeared to need more experience with rubrics. In general, the results demonstrated that professional development in performance assessment is worthwhile, but difficult to implement.

Borko, Mayfild, Marion, Flexer, and Cumbo (1997) conducted a study that helped teachers design and implement classroom-based performance assessments that were compatible with their instructional goals. Borko et al. examined the change process in mathematics by analysing conversations between teachers and researchers during workshops throughout the school year, as well as by interviews conducted at the beginning, middle, and end of the year. Their results were organised around five themes:

1. Situating the change process in the actual context of where new ideas will be implemented is an effective strategy for helping teachers change their practices.
2. Group discussions can be an effective tool for the social construction of new ideas.
3. Staff development personnel can facilitate change by introducing new ideas based on teachers' current level of interest, understanding, and skills.
4. When teachers' beliefs are incompatible with the intentions of the staff development team and are not challenged, the teachers are likely to either ignore the new ideas or inappropriately assimilate them into existing practice.
5. Time is a major obstacle to changing classroom practice (p. 259).

While performance-based assessment has gained reliability as an appropriate approach for improving the learning and teaching of science (Guy & Wilcox, 2000), it is not a given that teachers can easily and rapidly learn to implement such strategies in the classroom (Akerson, Morrison, & Mcduffie, 2002). Several studies (Borko, Mayfield, Marion, Flexer, & Cumbo, 1997; Howell, Brocato, Patterson, & Bridges, 1999) found that teachers need substantive and sustained professional development to effectively use and realise the benefits of performance assessment strategies.

4. The Requirements of the Implementation of Performance-Based Assessment

Howell et al (1999) contend that implementing performance-based assessment in the classroom requires substantive changes to current teaching practices. For instance, assessment strategies would need to be integrated with instructional methods, blurring the distinction between teaching and testing. However, with such changes, students would be more active and motivated to learn. For that reason, teachers should develop their teaching methods and change their traditional thinking about teaching and learning science. Unfortunately, many people continue to believe that students should rely on the memorisation of textbooks and lessons as their primary sources of knowledge; in this perspective, any type of teaching methodology that deviates from the standard represents undesirable behaviour. This type of thinking is rooted in the belief that "students' brains were like empty vessels waiting to be filled with knowledge imparted by a teacher" (Hinrichsen & Jarrett, 1999, p. 4). Moreover, some teachers hold that students lack the ability to learn independently and must be educated through direct teacher-to-student learning.

Despite these reservations, the results from various cognitive and developmental psychology studies have begun changing conventional thinking about teaching and learning. The constructivist approach, which aligns with performance-based assessment, has had an influential impact on science education over the past two decades (Aubusson & Watson, 2003; Kim, 1999). Alesandrini and Larson (2002) summarise the constructivist tenets as follows:

1. Learning results from experimentation and discovery.
2. Learning is a community activity facilitated by shared inquiry.
3. Learning occurs during the constructivist process.
4. Learning results from participation in authentic activities.
5. The outcomes of constructivist activities are unique and varied.
6. Constructivism clearly represents a fundamental change in all aspects of the teaching and learning process.

Constructivists also claim that students use their life experiences to construct meaning and knowledge (Aubusson & Watson, 2003). Consequently, students bring past understanding to the classroom that is difficult to change by traditional teaching methods. As this understanding is based on real life experience, it is strongly explanatory and thus influences the learning of connected concepts (Aubusson & Watson, 2003). This may partly explain why students usually forget what they learn by traditional methods. Moreover, according to this approach, "knowledge is not an entity that is waiting to be discovered, it is an ongoing process of criticism and creation" (Chang, n.d., p. 2).

Thus, teachers have now begun recognise that learning occurs best through personal experience and by linking new information to what students already know. In addition, many educators have asserted that students learn better when they do something personally rather than just observing something being done: this allows students to construct their own meaning regardless of how clearly teachers or books tell them things (Hinrichsen & Jarrett, 1999).

Constructivist science is emerging as the dominant strategy for learning and teaching (Diskin, 1997; Gagnon & Collay, 2001). Several practical classroom applications of the constructivist approach have been developed. For example, Gagnon and Collay (2001) designed a constructivist learning plan involving six elements that would be beneficial for teachers to consider:

1) **Situation**: What situation will you arrange for students to explain? Give this situation a title, and describe a process of solving problems, answering questions, creating metaphors, making decisions, drawing conclusions, or setting goals. This situation should include what you expect the students to do and how students will make their own meaning.
2) **Groupings**: There are two categories of groupings:
    a. How are you going group the students: as a class, individually, or in collaborative thinking teams of two, three, four, five, six, or more? What process will you use to group them: counting off, choosing a colour or piece of fruit, or similar clothing? The decision depends on the situation you design and the materials that are available.
    b. How are you going to arrange the groupings of materials that students will use to explain the situation: physical modelling, graphical representation, numerical description, or individually writing about their collective experience? The number of sets of

materials that are available will determine the number of student groups that can be formed.

3) **Bridge:** This initial activity determines students' prior knowledge and helps build a "bridge" between what they already know and what they might learn by explaining the situation. This might involve activities such as giving them a simple problem to solve, a class discussion, playing a game, or making lists. Sometimes this is best done before students are in groups, and sometimes after they are grouped.
4) **Questions**: Questions could be offered during each element of the learning design. What guiding questions will you use to introduce the situation, arrange the groupings, set up the bridge, keep active learning going, prompt exhibits, and encourage reflections? You also need to anticipate questions from students, frame other questions to encourage them to explain their thinking, and stimulate them to continue to think for themselves.
5) **Exhibit**: Students should exhibit the record of their thinking they created as they were explaining the situation. This could include writing a description on cards and giving a verbal presentation, making a graph, chart, or other visual representation, acting out or role-playing their impressions, constructing a physical representation with models, or making a video tape, photographs, or audio tape.
6) **Reflections**: These are the students' reflections on what they thought about while explaining the situation, as well as their impressions of the other exhibits. They would include what students remembered from their thought process about feelings in their spirit, images in their imagination, and languages in their internal dialogue. What attitudes, skills, and concepts will students retain? What did students learn today that would be remembered tomorrow? What did they know before? What did they want to know? What did they learn? (Para. 6).

5. Components of Performance-based Assessment

Performance-based assessment comprises three elements: a performance task, a rubric, and a response form (see figure 5.1).

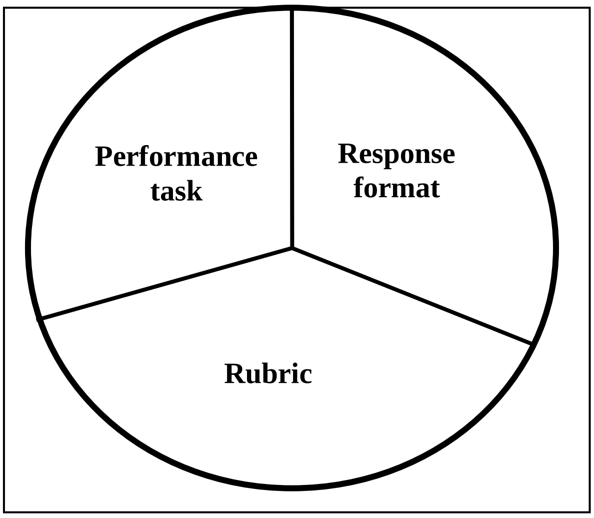


Figure 5.1 Components of Performance-based Assessment, from Brown & Shavelson, (1996).

5.1 Performance-Based Task

The Alaska Department of Education & Early Development [ADEED](1996) defines performance tasks as "learning activities that are scored according to specified criteria" (pp. 10-11). Thus, typical assessment tasks encourage students to generate a product or engage in worthwhile activities that can be observed and measured (Wangsatorntanakhun, 1997).

Tasks can be designed or selected. It should be remembered that "Creating effective assessment tasks require thinking through curriculum content to establish learning outcomes, then designing performance activities that will allow students to demonstrate their achievement of those outcomes and specifying criteria by which they will be evaluated" (Cohen, 1995, p. 1).

Herman, Aschbacher, and Winters (1992) suggest following a 10 step process to design an assessment task:

1. Clearly state the purpose for the assessment.
2. Clearly define what it is you want to assess (learning outcomes).
3. Match the assessment method to the achievement purpose and the target in Step 2.
4. Specify the illustrative tasks that require students to demonstrate certain skills and accomplishments.
5. Specify the criteria and standards for judging student performance on the tasks selected in Step 4.
6. Develop a reliable rating process that allows different “raters” at different points in time to obtain the same or nearly the same results.
7. Avoid the pitfalls that threaten reliability and validity and can lead to the evaluation of students.
8. Collect evidence/data showing that the assessment is reliable and valid.
9. Ensure consequential validity.
10. Use the test results to refine the assessment and improve the curriculum and instruction.

While all of the steps are important, Steps 5 and 6 are considered the essence of assessment tasks. For that reason, they are discussed in detail below.

5.2 Criteria

The National Center for Research, Evaluation, Standards, and Student Testing defines *criteria* as "guidelines, rules, characteristics, or dimensions that are used to judge the quality of student performance. Criteria indicate what we value in student responses, products, or performances"(as cited in North Central Regional Educational Laboratory [NCREL], n.d., Para 1). Developing specific criteria concentrates attention and efforts on exacting student behaviours that are observable and measurable (Wangsatorntanakhun, 1997). Each performance assessment task must have performance criteria for two reasons: first, to define the desired product and expected goals for students, and second, the criteria allow teachers and students to assess their own work (Allen, 1996). Herman et al. (1992) note that students perform better when they can identify the goal, are shown models, and know how their work compares to the standard.

Airasian (as cited in Brualdi, 1998) suggests the following steps for designing criteria:

1. Identify the overall performance or task to be assessed. Perform it personally or imagine performing it.
2. List the important aspects of the performance or product.
3. Try to limit the number of performance criteria so they can all be observed during a pupil's performance.
4. If possible, have groups of teachers think through the important behaviours included in a task.
5. Express the performance criteria in terms of observable pupil behaviours or product characteristics.
6. Do not use ambiguous words that cloud the meaning of the performance criteria.
7. Arrange the performance criteria in the order in which they are likely to be observed.

The best criteria for assessing student performance are developed based on classroom expectations; they should clearly define the full dimensions of the performance or the features being assessed. “Each criterion must be teachable in the sense that teachers can help students increase their ability to use the criterion when tackling tasks that require that skill” (Popham, 1997, p. 5). If the performance criteria are well defined - and matched or formed with examples where possible - the students will understand what they must do to reach high levels of performance (Allen, 1996).

5.2.1 Rubric

Although criteria may take several forms, scoring criteria known as a *rubric* is the most familiar. A rubric is a scaled set of criteria that clearly defines the range of acceptable and unacceptable performance for students and teachers. The criteria provide descriptions of each level of performance in terms of what students are able to do and assigns values to these levels (Pate, Homestead, & McGinnis, 1993).

While traditional tests such as multiple-choice exams have answer keys indicating the correct answer, performance-based assessments do not yield a single correct answer, but ask students to react to a task in a range of ways. Consequently, a set of "rubric" - based on the amount of a full range of criteria rather than a single arithmetical score - are usually employed to evaluate student performance. A good rubric provides a fair and objective evaluation. (Herman, Aschbacher, & Winters, 1992) note that a good rubric will:

- Assist in defining "excellence", and plan how students can achieve it.
- Communicate to students what constitutes excellence and how to evaluate their own work.
- Communicate goals and results to parents and others.
- Help teachers or other raters be accurate, unbiased, and consistent in scoring.
- Document the procedures used in making important judgments about students.
- Students can use rubrics as a tool to develop their abilities.

A rubric works as a guide for both students and teachers. It is provided to students before the assessment task begins to inspire them to think about the criteria that are the basis for their performance.

A rubric can be analytic or holistic: analytic rubrics identify and assess components of a finished product, while holistic rubrics assess student work in its entirety (Herman, Aschbacher, & Winters, 1992). Both types have a role in performance assessment according to certain factors (e.g., the subject matter being assessed, the type of task, the number of teachers, and the nature of the students). However, it should be noted that many educators suggest that a holistic rubric is more appropriate for younger students.

5.3 Responses Format

The third component of a performance assessment is the response format: students use it to communicate their findings in different ways according to the nature and the goals of the task. For example, students may be asked to summarise or explain their findings, draw a diagram, or list the steps they used. Brown and Sahvelson (1996) summarise the main characteristics of a performance assessment response in the following figure: :

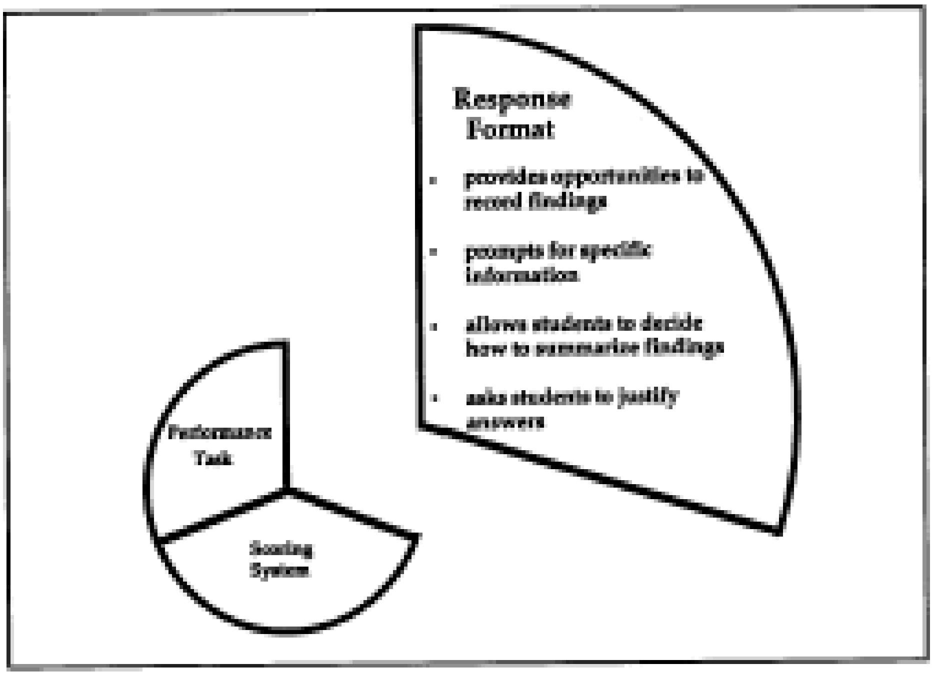


Figure 5.2 Responses Format from Brown and Sahvelson (1996), Assessing Hands-On Science: A Teacher's Guide to Performance Assessment.

6. Selecting assessment task

Allen (1996), and Wangsatorntanakhun(1997) suggest that selecting rather than designing a task may be the best method when first using performance-based assessment in the classroom. Performance activities developed by other teachers can often be adapted. The selection of performance assessment tasks should follow certain criteria:

- Does the task truly match the outcome(s) you are trying to measure?
- Does the task require the students to use critical thinking skills?
- Is the task a worthwhile use of instructional time?
- Does the assessment use engaging tasks from the “real world”?
- Can the task be used to measure several outcomes at once?
- Are the tasks fair and free from bias?
- Will the task be credible?
- Is the task feasible?
- Is the task clearly defined? (Adapted from Herman and Aschbacher in Chicago Board of Education, 2000).

Whether designing or selecting tasks, performance tasks should have the following features:

Essential	• The task fits into the core of the curriculum. • It represents the big idea.	vs.	Tangential
Authentic	• The task uses processes appropriate to the discipline. • Students value the outcome of the task.	vs.	Contrived
Rich	• The task leads to others. • It raises other questions. • It has many possibilities.	vs.	Superficial
Engaging	• The task is thought provoking. • It fosters persistence.	vs.	Uninteresting
Active	• The student is the worker and the decision-maker. • Students interact with other students. • Students are constructing meaning and deepening understanding.	vs.	Passive
Feasible	• The task can be done within school and homework time. • It is developmentally appropriate for students. • It is safe.	vs.	Infeasible
Equitable	• The task develops thinking in a variety of styles. • It contributes to positive attitudes.	vs.	Inequitable
Open	• The task has more than one right answer. • It has multiple avenues of approach, making it accessible to all students.	vs.	Closed

(From Alaska Department of Education & Early Development [A.D.E.E.D], 1996)

7. Description of Performance-Based Assessment Program

The Performance-Based Assessment Program was designed for primary school students, particularly Grade 6 students. This section involves two parts: The first part describes the assessment strategies - drawn from the literature - that were used to design the program. The second part provides teachers with the processes that should be followed when implementing performance-based assessment in the classroom.

7.1 Performance Assessment Strategies

The program strategies are divided into four elements: technique, assessor, performance, and time (see figure 7.1). However, the elements are intergraded where each one complements the others.

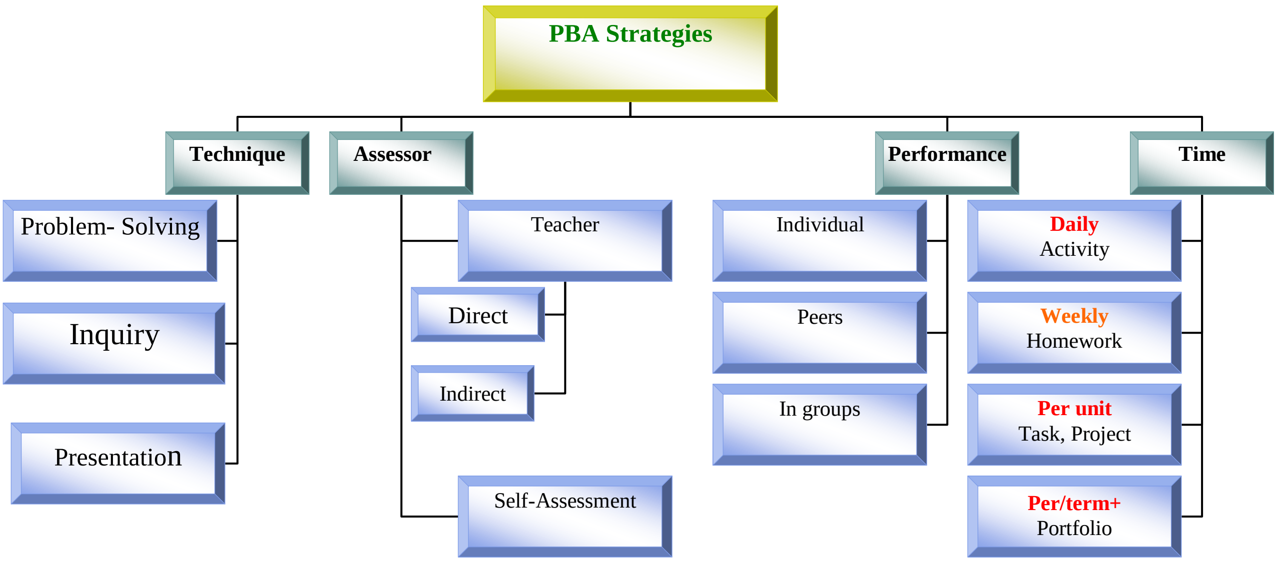


Figure7.1 Performance-Based Assessment Strategies

In the following detail for each element:

7.1.1 Assessment Technique

As noted earlier, a performance assessment task is formed according to the nature of the subject and the intended goals. When reviewing the assessment techniques described below, consider which is the most probable for a subject you are intending to teach. Remember, selecting such a technique depends on a clear understanding of the purpose and expected outcomes. Furthermore, when choosing the technique and design or selecting the task suitable to your situation, keep the assessment processes simple; in other words, do not ask students to perform or gather data beyond the needed outcomes (Enerson, Plank, & Johnson, 1994).

As a science teacher, choose from a variety of techniques that best meet your learning outcomes. The following assessment techniques are examples of classroom-based assessments.

7.1.1.1 Problem Solving

Problem-solving is defined as a process involving the application of knowledge and skills to achieve a goal when a solution method is not obvious to the problem solver (Rothstein, 1990). As a teaching approach in the context of elementary science, problem solving refers to inducing students to use their higher order thinking skills by "asking relevant questions, exploring, formulating hypotheses, planning investigation, predicting outcomes, experimenting, collecting and evaluating data, drawing conclusions" (Lee , Tan, Goh, Chia, & Chin, 2000, p. 115).

Although problem solving is commonly held to be a goal of elementary science instruction, some studies (Lee , Tan, Goh, Chia, & Chin, 2000) indicate that teachers do not tend to use problem-solving strategies in the classroom. The reasons include personal factors, such as a lack of knowledge, skills, and self-confidence, and external factors, such as time limitations in the curriculum, students' abilities, and a lack of support from school administrators (Lee et al., 2000).

However, problem solving opportunities occur in the daily lives of students, and science teachers can use these social and cognitive activities and experiences in systematic ways (Joan, 1993; Taconis, Hessler, & Broekkamp, 2001). Whether individually or in groups, students can use the following problem-solving methodology:

1) Identify the problem.
2) Brainstorm a variety of solutions.
3) Choose one solution and try it out.
4) Evaluate what has happened (Joan, 1993).

Goffin (as cited in Joan, 1993) suggests questions that can be used by teachers as a guide to identify the appropriate problems for students:

1) Is the problem meaningful and interesting?
2) Can the problem be solved on a variety of levels?
3) Must a new decision be made?
4) Can the actions be evaluated?

Problem-Based Learning (PBL), first created and employed in medical schools but subsequently adapted for use in the elementary science classroom, is a new approach to problem-solving that requires consideration (Gallagher & Stepien, 1995). The PBL approach identifies three principle characteristics for all problems: first, there is a primary state in which students begin; second, there is a goal state they wish to accomplish; and finally, there are processes needed in order to get from the initial state to the goal state (Greenwald, 2001). Using the classic problem solving method, students still encounter problems even after all of the relevant information has been taught and the necessary data and tools have been made available. In contrast, learning in the PBL method starts after the students face the problem. Moreover, PBL depends on the level of clarity of the three characteristics of a problem. This approach assumes that there is insufficient information to develop solutions for most problems in the real world; thus, learning should reflect this reality and "raise questions about what is known, needs to be known and how to find out" (Greenwald, 2001, Para. 6).

Any problem solving approach generally has benefits. Joan (1993) suggests that problem solving is a method to make sense of the environment and, in actuality, to manage it. Teaching problem solving strategies allows students to be active participants in and, in certain circumstances to make changes to, an increasingly varied world.

7.1.1.2 Inquiry

Inquiry is the second necessary technique and, in fact, complements problem solving. The National Science Education Standards (as cited in Fetters, Beller, & Hickman, 2003) describe inquiry as a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyse, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations (p. 23).

Hebrank (2000) notes that inquiry methods are an excellent science teaching tool for all students. He defines "excellent science teaching" and how inquiry can provide it through the articulation of nine features:

1) Science is taught as a process as well as a body of content.
2) Science content relates to students' everyday experiences, and capitalises on and encourages students' questions and curiosity.
3) Instruction minimises or eliminates lecture and textbook methods.
4) Instructional methods take into consideration the different developmental stages of students.

5) Assessment methods allow students to demonstrate proficiency in a variety of ways.
6) Inquiry science teaching can be integrated with math, social studies, and/or language arts curricula.
7) Inquiry facilitates the development of good communication skills through the sharing of scientific ideas and findings, and allows students to learn from each other.
8) Inquiry helps to create critical – as in questioning and sceptical - citizens and consumers.
9) Inquiry contributes to the ultimate goal of enabling students to become good stewards of their own bodies and the planet they live on.

Hinrichsen and Jarrett (1999) suggest there are four components essential to inquiry science:

1) **Connecting**: Connecting is the process where students link their prior knowledge with new experiences while conducting an inquiry investigation. Teachers can facilitate connecting by posing questions or problems and encouraging students to discuss and explain their current understanding. Discussion gives students the opportunity to demonstrate their knowledge of the subject matter, as well as modify their understanding according to the discussion outcome. Moreover, discussion can minimise the differences in personal experiences between students. Teachers can also ask students to conduct an inquiry investigation to observe and describe the changes of a phenomenon. The most common technique for observing changes in students' understanding is to require them to form hypotheses or predictions before implementing an activity, record the results of the activity, and then compare the predictions and the findings.
2) **Designing:** Designing is the process students use to gather data to answer their questions. Teachers can facilitate designing by encouraging students to create a plan that clearly illustrates the procedure for collecting the

relevant data. A student should be able to discuss their plan with the teacher and justify their choices.

3) **Investigation:** Investigation is the process where students carry out the procedures of their plan. The purpose is to collect qualitative or quantitative data according to a specific strategy. It may involve experimentation, measuring, observation, or creation. Students should evaluate the effectiveness of their plan while performing the investigation.
4) **Constructing Meaning:** "Constructing meaning is the process of analysing the data which has been collected, examining patterns and trends in the data, and using them to formulate explanations"(Hinrichsen, 2003, p.1). Instead of searching for an answer in a textbook, which usually does not provide deep understanding, students interact with scientific concepts through conducting, activity, analysing, evaluating, and identifying their own data.

7.1.1.3 Presentation

Presentations involve students in a variety of activities that are both process- and product- oriented. Students collect information and organise it. They analyse what is needed for a specific purpose and bring together various elements into a whole. They record the material in a manner they have chosen that will best display their learning process. They communicate to an audience what they have learned through visual, audio, and/or kinaesthetic means. In becoming involved with a presentation, students interact with the material they are learning (Saskatchewan Education, 1991).

Presentations also provide students with the opportunity to demonstrate a range of scientific communication skills and their understanding and application of scientific knowledge (curriculum@work, 2000)**.**

Presentations can provide ideal circumstances for assessing students' progress, knowledge, skills, and attitudes. However, it should be recognised that some students may experience difficulty presenting their work in front of the class. Saskatchewan Education (1991) suggests these assessment guidelines for presentations:

- Students should know how they are being assessed.
- Some students may not have the self-confidence necessary to stand up in front of their class. Teachers should consider the following questions before assigning presentations to students:
    - Have I established an atmosphere of acceptance in my classroom so students will feel confident that what they present will be well received?
    - Do I have students who might experience difficulties that would obstruct their ability to give a presentation? If so, what modifications can be made so that they can present to their best ability?
    - Have I established expectations about how and why these presentations will be assessed?
    - Have I thought through how I will help or modify the situation for students who might find this activity extremely stressful?

7.1.2. Assessor

7.1.2.1 Teacher

A teacher can assess students in two integrated ways: the first involves attaching a rubric to every student activity, and the second requires observation of a student while they work in the classroom. Observation is a common informal method that can be used to assess attitudes, values, and communication and process skills. The A.D.E.E.D (1996) offers the following suggestions for employing the observation technique:

- Use observations to collect data on behaviours that are difficult to assess by other methods (e.g., attitude toward problem solving, selection and usage of a specific strategy, modelling a concept with a manipulative, ability to work effectively in a group, persistence, concentration).

- Observe and record the way students solve problems and complete tasks.
- Ascertain whether students (individually or in a group) are attaining the intended objectives. Consider: Do I need to re-teach? Are students ready to move on?
- Record and date your observations during or soon after the observation. Develop a shorthand system. Distinguish from inferences.
- Observe students in a natural classroom setting so you can see how they respond under normal conditions. It is easier to observe if students are working in small groups rather than alone.
- Have an observation plan, but be flexible enough to note other significant behaviours. You may find it helpful to record much behaviour for one student, or one behaviour for many students.
- Use technology like Newton or barcode readers.

7.1.2.2 Student

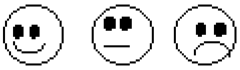
Self-assessment is defined as “a process by which a learner is empowered to make explicit judgements about the achievement of, or progress towards, curricular goals”(Lee & Gavine, 2003, p. 50). Self-assessment has become an essential step in the learning process: students need opportunities to monitor their progress, regulate their efforts, and appraise the quality of their work (Luongo, 2000). Given the results of recent studies (Black & William, 1998b), self-assessment should be considered an inevitable practice rather than an accidental process. Self-assessment helps students develop higher level thinking skills, become more responsible for their own work, and consequently strengthens their performance (A.D.E.E.D, 1996; Luongo, 2000). Moreover, student self-assessment can provide teachers with important information that can help improve teaching and learning. It is common for students to experience difficulty assessing their performance or attitudes at first; until students gain the necessary skills to assess themselves independently, teachers must be patient and encourage the regular practice of self-assessment.

There is a wide range of classroom assessment strategies available to teachers. The following self-assessment forms are some examples that can be used by students.

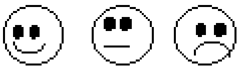
Example #1:

Reflective Feedback:

How did you feel about this activity?



Would you like to do this activity again?



(From A.D.E.E.D, 1996)

Example #2:

I do not understand the problem	1	3	5	I can explain this problem
I cannot recognize the important and unimportant parts of this problem	1	3	5	I can recognize the important and unimportant parts of this problem
I do not know where to start	1	3	5	I can solve the problem & explain my solution
This was a difficult problem	1	3	5	This was an easy problem

Comments:

(From A.D.E.E.D, 1996)

Example #3:

Student Self-Assessment of Individual/Group Projects and/or Performance Station Tasks

Name: ______________________ Date: ______________

Task or Project: ______________________________

Who worked with me?	
What did I do?	
How well did I do?	
How do I feel now?	
What was the best part?	
What would I like to do next?	

(From Saskatchewan Education, 1999)

Example #4:

Reflection Activity

Performance Task Questionnaire

Performance Task Completed: ______________________________

Think about the learning activities and performance task you have just finished.
Now, answer the questions below in the space provided.

What activities did you enjoy most? Why? ______________________________

____

List three interesting facts you learned about the topic.

1. ______________________________
2. ______________________________
3. ______________________________

What strengths did you demonstrate during the task? ______________________________

____

____

What skills have you developed or improved?
How? Describe what you are now able to do that you could not do before.

____

____

What activities did you find difficult or challenging? Why? ______________________________

____

____

How did you deal with these problems? What strategies did you use?
Describe how other people, materials, and resources helped you with the difficult parts of the task.

____

____

How would you change the lessons and performance task? ______________________________

____

____

What are your future goals for improvement?

1. ______________________________
2. ______________________________
3. ______________________________

Discuss your responses from the questionnaire with others.
What suggestions from others will help you improve your performance and reach your goals?

1. ______________________________
2. ______________________________
3. ______________________________

7.1.3. Performance: Individual, Peer, and Group Work

There are three main ways a student can perform in the classroom: working individually without considering the efforts of other students, working individually but competing with other students to find out who is the best, and working cooperatively in a group (Johnson & Johnson, 1988). The first two ways clearly dominate current learning practices in schools; however, the third method is nearly implemented in the classroom. This situation may exist because teachers do not receive enough learning and training about cooperative methods, but it is certainly not because individual learning has been conclusively proven the most beneficial. In fact, most comparative studies have found the cooperative method much more effective (Johnson & Johnson, 1988; Lawrence & Harvey, 1988; Miller & Peterson, 2002). After reviewing 122 studies conducted between 1942 to 1980 that compared individual, competitive and cooperative learning, Johnson and Johnson (1988) dnuof:

1. Students learn more by cooperative interaction than other ways.
2. Students are more positive about teachers, subject areas, and school when they learn cooperatively.
3. Students are more positive about each other when they are made to work cooperatively.
4. Students are more effective interpersonally as a result of working cooperatively.

In another study, Johnson and Johnson, employing a meta-analysis of 323 studies on the impact of the three types of social interdependence on achievement, found that "the students at 50th percentile in a cooperative learning situation will perform at the 75th percentile of students learning in a competitive situation and at the 77th percentile of students learning in an individualistic situations" (as cited in Sharan, 1990, p. 24). When analysis was limited to the high-quality studies, students at 50th percentile of the cooperative learning situation performed at 81st percentile of the competitive and individualistic learning.

While there are many strategies available, teachers should consider the following key elements when utilising cooperative learning methods:

- **Group size:** The appropriate size for a group depends on many factors: class size, time, available tools, and the students’ skills. Groups should be small if the students do not have sufficient communication skills, the lesson time is less than one hour, or there are not enough resources and tools. Pair groups are sometimes the optimal size as students solve problems together, share ideas, or explore a question.
- **The homogeneity of groups:** Many educators (Johnson & Johnson, 1988; Solano-Flores, 1997) consider heterogeneous groups more effective. Students with different needs, abilities, and attitudes enhance learning by their need to discuss, explain, and argue with each other while developing solutions or producing products.

7.1.4. Assessment Time

Assessment is a continuous process that should be integrated with teaching and learning. If the primary purpose of assessment is to improve student learning, dynamic changes need to occur in day-to-day classroom assessment and instructional practices (Enright, 2002). Daily assessment gives teachers quick feedback about student progress; consequently, student needs can be analysed, and problems can be identified and overcome before beginning another lesson. Traditional assessment relies on assessing achievements at the end of the unit; if a student misunderstands the unit lessons, the teacher has to either re-teach the whole unit, particularly if understanding each lesson depends on knowledge acquired earlier, or proceed to the next unit and risk leaving the low-achieving students behind. In either case, students that could not keep up with the lessons would be less motivated and develop a negative self-image.

In their examination of numerous studies, Black and Wiliam (1998b) found that daily assessment helps low-achieving students, decreases the achievement gap between students, and increases overall achievement. Moreover, they found that

> Pupils who come to see themselves as unable to learn usually cease to take school seriously. Many become disruptive; others resort to truancy. Such young people are likely to be alienated from society and to become the sources and the victims of serious social problems (Black & William, 1998b, p. 3)**.**

Other forms of assessment are also important for teaching and learning. Weekly assessment can be used to reinforce skills taught in the classroom, adjust teaching, and develop students' responsibility for their own learning. Weekly assessment can also be tailored to meet particular needs based on the feedback received about student progress and the achievement of specific learning goals.

Per-unit assessment, which usually requires periods longer than a week, can involve two different types of assessment. The first gives students the opportunity to choose from different assessment tasks according to what suits their particular abilities and attitudes, and to use compound skills that need a particularly long period to be mastered. The second type, which is usually conducted in the classroom, gives clear feedback to both teachers and students about their efforts over the unit period.

All type of assessment tools are usually familiar to both teachers and students or impeded teaching plan where students some time may not be aware of it, except two tools: the project and portfolio:

Project

Every classroom contains students possessing a broad range of abilities and attitudes. Ideally, individual differences should be considered in student learning, but regular classroom practices simply cannot account for the diversity. Moreover, it has become clear that students have a much greater variety of abilities and capacity to learn than they actively use in the classroom. Therefore, new learning environments that are responsive to the individual differences that affect learning are required (Chard, 2001).

One methodology developed to meet these diverse needs is the project approach. A project is an in-depth investigation of a real-world subject that can be carried out individually or in a group (Chard, 2001). Projects enhance student learning through first-hand research, primarily in science, and provide the opportunity to present the results of their work in various formats (Chard, 2001).

Assessing a project means assessing the students' ability to perform in "real life" tasks and situations. In addition, this type of long-term assessment provides students with the chance to master skills that are too time-consuming or intensive to learn in a regular classroom setting (e.g., creativity, planning skills, investigation, and the ability to integrate knowledge) (Miami Museum of Science [MMS], 2001).

Portfolio

A portfolio is a collection of information by and about a student to give a broad view of his/her accomplishment. It contains samples of student work in one or more areas (Mabry, 1999). Arter and Spandel (as cited in William & Robert, 1999) describe a portfolio as "a purposeful collection of student work that tells the story of the students' efforts, progress and achievement" (p. 6). Moreover, it is a form of alternative assessment that combines both authentic and performance strategies in order to demonstrate students' improvement and development over time (William & Robert, 1999). Although portfolios can be used in many subject areas, they are best employed with the new instructional approach that embraces constructivist notions (Sweet, 1993). There is also the added advantage that it allows students to save their work, review their progress over time, and stimulates thinking about how they can improve in the future (Sweet, 1993).

Portfolios have been widely implemented for classroom assessment and accountability at educational institutions in the United States (Vermont, Kentucky, and New Jersey), as well as in most districts in Australia and Canada.

The North American Division Office of Education [NADOE] (2000) notes that portfolios are valuable tools because they offer the following benefits:

Teaching

- Illustrate student growth and progress over time.
- Provide teachers with insight into their own teaching.
- Assist teachers in assessing their progress towards reaching the objectives of the course.
- Provide an illuminating focal point for teacher-parent and student-led conferences.
- Organise documents and artefacts for grading purposes.

Student Learning and Achievement

- Facilitate and motivate students to learn.
- Make students aware of and assume responsibility for their learning.
- Improve critical thinking through metacognition.
- Enhance student self-esteem by showing their best work.
- Help students evaluate the value of their work.
- Present a body of evidence of student accomplishment.
- Offer the opportunity for developing analytical, problem solving, and reasoning skills.

Communication

- Improve communication among students, teachers, and parents.
- Provide concrete evidence of a student’s work and growth.
- Provide insights into how well students meet curriculum goals.

7.2. Performance-Based Assessment Guide

The Performance-Based Assessment Program includes three science units (Electricity, Magnets and Science in the Service of Humans) from Term 3 of Grade 6. As most of the elements are based on science inquiry, a single model of science inquiry techniques should be used (see integration instructions with assessment).

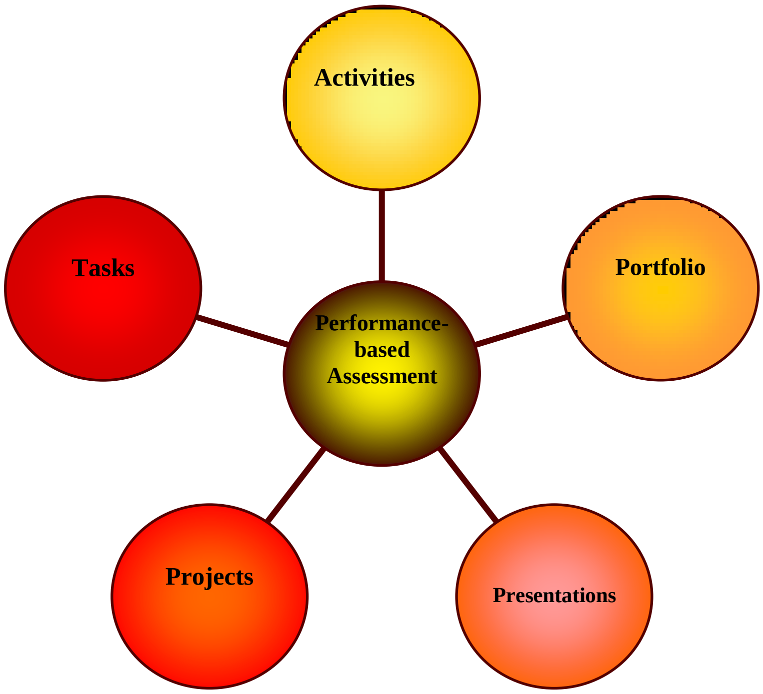


Figure 7-2 the elements of Performance-based assessment Program

Each unit involves the following elements as shown in Figure 7-2:

1) **Activities:** An activity is usually an investigation based on inquiry science that students complete in the classroom. Teachers should be limited to the role of a facilitator, intervening only in key moments without providing direct answers. Students can perform the activities individually or in

groups; however, most program activities are designed for cooperative learning environments. Each activity has a student sheet and a teacher sheet. Apart from the main task, the student sheet contains:

a. **The Instructional Rubric:** Student performance is assessed against a rubric that encompasses three dimensions of essential learning (knowledge and thinking, communication, and values and attitudes). In each activity, the rubric focuses on one element and supports the others, demonstrating the content of essential learning (objectives). While some rubric criteria can be assessed according to a student's response in their paper, some assessment depends on the teacher's observation of the student while they work at the activity. As such, the observation list may be required to complete the total rubric.

b. **The Self-Assessment Form:** Self-assessment is an essential component of the activity, but often students lack the skills to complete such a process or are unaware of its importance. Therefore, teachers must focus on the procedures and value of self-assessment, particularly in the first stage of the program. There are many possible techniques: showing students the importance of this process in their achievement, requesting that they complete the Self-Assessment Form, mentioning the self-assessment in the rubric, and discussing the self-assessment. The self-assessment forms were simplified for the first activities in the hope that the requisite skills would develop with practice. The Teacher Sheet provides the teacher with the objective(s) and construction of the activity.

2) **Homework:** The homework was designed to:

a. Support the instruction and textbook
b. Provide students with information about the scientific concepts that are required in accessing inquiry science.
c. Stabilise student understanding by giving them more implementations and illustrations related to the past activity.
d. Cover the relevant aspects that were not taught in the class.

e. Help low-achieving students by giving them extra work.

The homework usually involves small topics with some questions and then increases gradually in difficulty.

3) **Projects:** Each unit has several projects, which students can select according to their interests. The project lasts approximately 2-3 weeks, or according to the unit length. Teachers should follow up with the students while they are working on their projects to ensure they are following the project schedule and doing their own work.
4) **Presentation:** As time restrictions usually apply, teachers should choose approximately 8-10 students to present their work per unit. The presentations should be assessed against the presentation rubric. Provide students with a copy before the presentation so they are aware of the assessment criteria. They should also receive a copy of the actual presentation assessment.
5) **Tasks:** The tasks should be administered at the end of the unit to assess progress in some or all of the scientific concepts and processes. Although it is possible to complete them in groups, ideally the tasks would be performed individually (if the materials are available). The construction of the task is somewhat similar to the activity construction; however, the procedures of the task should be more rigorous, and you will find the rubric concentrates more on the knowledge and thinking elements.
6) **Portfolio:** The portfolio is a new assessment tool; as such, it requires special explanation and encouragement when presented to students. The following ideas may help the introduction of the portfolio:
   a. Show that successful people such as writers and designers use portfolios to present their work (samples would be valuable).
   b. Engage your students in a discussion of the types of work they might choose and the reasoning for such choices.

c. Establish a basic plan that shows how many work samples will be included in the portfolio, what they will be, and when they should be selected.
d. Guide your students in completing their work

7) **Games:** The aim of this program is to improve student attitudes towards science and increase the quality of their learning. Thus, all of the previous elements were designed to allow students to enjoy completing their work. In this respect, games related to the unit subjects can be employed, whether in their free time or at home, to great effect.

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Appendix D
The Final science test

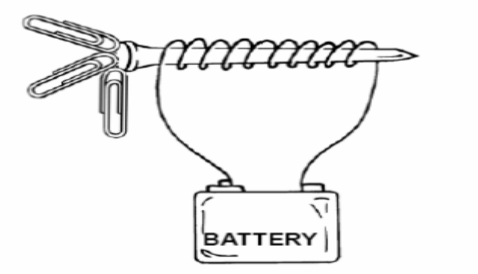
Involving items adapted from: TAKS: Texas Assessment of Knowledge and Skills (2004), Information Booklet, Elementary Science. From http://www.tea.state.tx.us/student.assessment/taks/booklets/science/g5e.pdf; *Release of Spring 2004Test Items*, Massachusetts Department of Education. From http://www.tea.state.tx.us/student.assessment/taks/booklets/science/g5e.pdf; SCIENCE SAMPLE TEST BENCHMARK 2, 2003-2005, Physical Science, Life Science, Earth and Space Science. Office of Assessment and Evaluation Oregon Department of Education. From http://www.ode.state.or.us/teachlearn/testing/samples/2002_03/science0305smptest-2.pdf; Fact, Florida Comprehensive Assessment test, science Sample Test Book (2005), Assessment and School Performance Florida Department of Education. From http://www.firn.edu/doe/sas/fcatrelease.html.

Answer all these questions:

1- Which type of electricity moves along a pathway to make a light turn on?

a. Static electricity
b. Lightning electricity
c. Turbine electricity
d. Current electricity

2- Rachel made four electromagnets by winding coils of copper wire around a nail. She connected each end of the wire to a battery to form an electromagnet which she used to pick up paper clips



In this experiment, what kind of energy is changed directly into magnetic energy?

a. Heat energy
b. Electrical energy
c. Chemical energy
d. Light energy

3- Ken wanted to make a light bulb glow. Which set of materials would he need?

a. paper cup, paper clip, and a popsicle stick
b. D-cell battery, wire, and a light bulb
c. button, D-cell battery, and a rubber glove
d. D-cell battery, paper, and a bulb

4- List of materials: piece of wood, a copper penny, a plastic knife, a balloon, a piece of Styrofoam¨, an aluminium screw, a rubber tube, a metal fork, a copper wire, a steel pipe

Insulators	Conductors
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

5- Sam was shown four objects, one of which did not contain a magnet. Which should he select as the one that does NOT contain a magnet?

a. Cassette recorder
b. Television
c. Electric can opener
d. Wind-up clock

6- Which is a form of static electricity that appears in nature?

a. rain
b. ocean currents
c. lightning
d. volcanoes

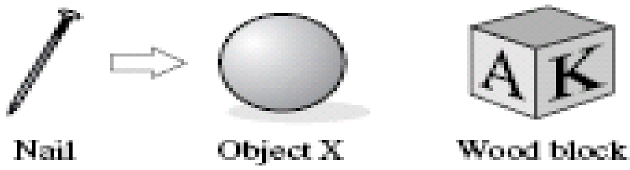
7- Two objects have collected static electricity with the same charge. What would the objects do when placed near each other?

a. repel
b. attract
c. nothing
d. stick together

8-What substance is attracted to a magnet?

a. silver
b. lead
c. water
d. iron

9- The picture below shows a nail being attracted by object X.



The nail moves toward object X, but the wood block does not. What kind of energy causes only the nail to move toward object X?

a. Light
b. Heat
c. Electric
d. Magnetic

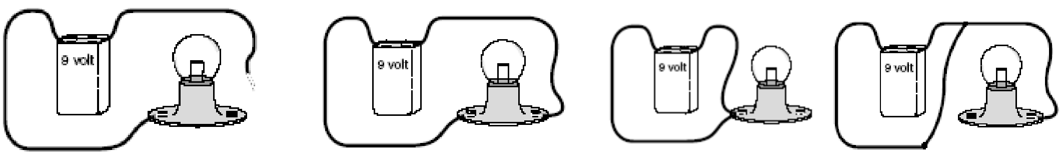
10- Look at the diagram of the magnets in set #1 and set #2. What do you predict will happen?

SET # 1

SET # 2

a. Set #1 will attract and Set #2 will repel.
b. Set #1 will repel and Set #2 will attract.
c. Set #1 and Set #2 will both attract.
d. Set #1 and Set #2 will both repel.

11- Which circuit will cause the light bulb to glow?



A B C D

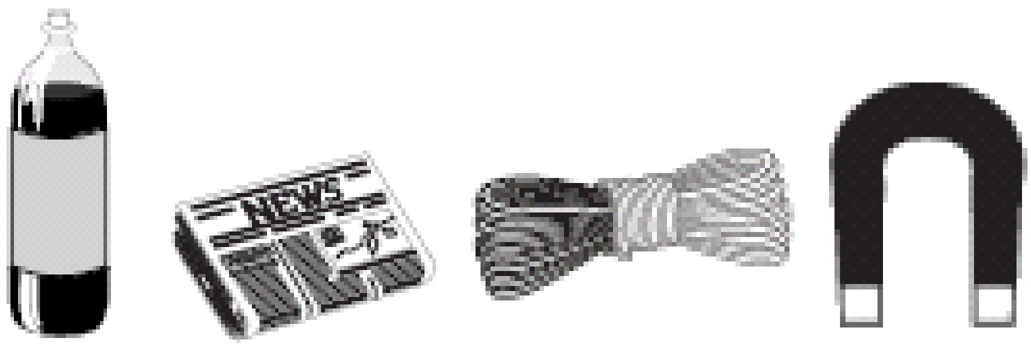
12- The switch is used for:

a. Opening or closing the circuit
b. Opening the circuit
c. Connecting the circuit
d. Closing the circuit

13- A compass needle always points to:

a. West
b. South
c. East
d. North

14- Which of the following objects will affect the direction that a compass needle points?

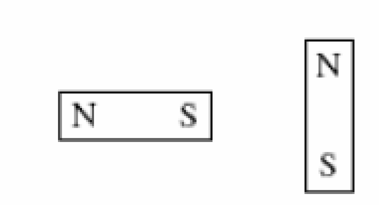


A B C D

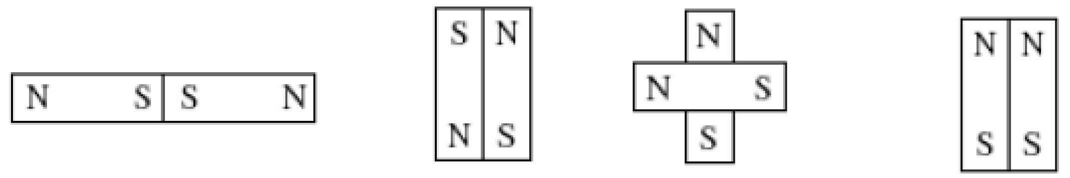
15- If you take a bar magnet and break it into two pieces:

a. Each piece will again have a North pole and a South pole
b. Each piece will keep half of the magnetic power
c. One piece gains a North pole and the other gains a South pole
d. Each piece will lose the magnetic power

16- The diagram below represents two bar magnets



Which of the following diagrams shows the effect of magnetic energy on the magnets as the two magnets above are moved closer together?

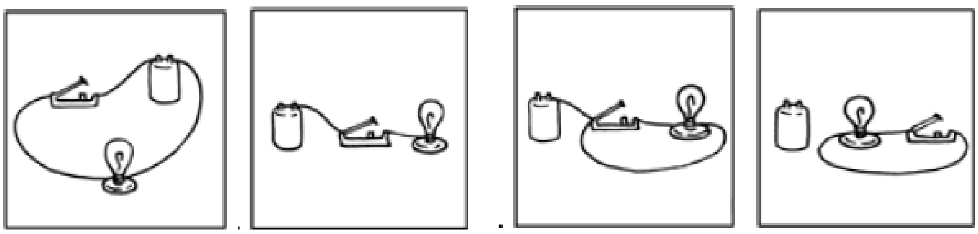


A B C D

17- Static electricity can be generated by:

a. Tying two objects
b. Bring together two objects
c. Sticking two objects
d. Friction two objects

18- Each picture shows a battery, a bulb, and a switch. Which bulb will light when the switch is closed?



A B C D

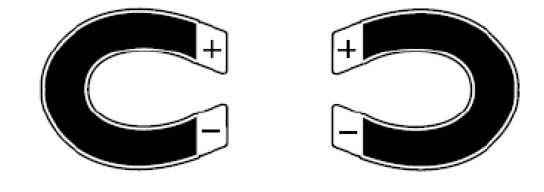
19- The two magnets were placed near each other on a table top. Which statement about the magnetic force of these two magnets is true?

a. The two magnets will be attracted to each other

b. The two magnets will repel each other

c. There will be no force between the magnets

d. The magnetic force will change the magnets



20- What will happen if you add more batteries to an electrical circuit containing light bulbs?

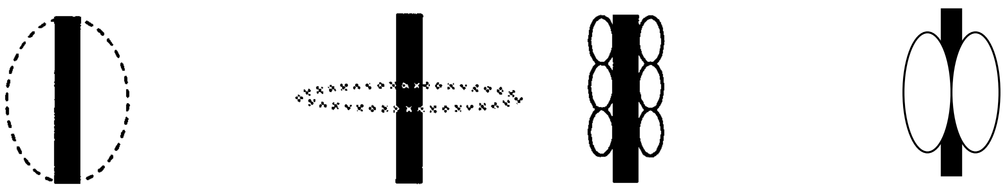
a. No change.

b. The bulbs will dim.

c. The bulbs will be brighter.

d. The bulbs will last longer.

21- Which of the following shows the correct shape of a bar magnets magnetic field?



A. B. C. D

22- Magnets can be used in:

a. An electrical generator

b. An electrical heater

c. An electrical lighter

d. Non of the above

23- The power of a magnet:

a. Distributes equally between its parts

b. Concentrates in its poles

c. Increases in the middle

24- Figure (1) has been coded in several forms. Which is the correct coding?

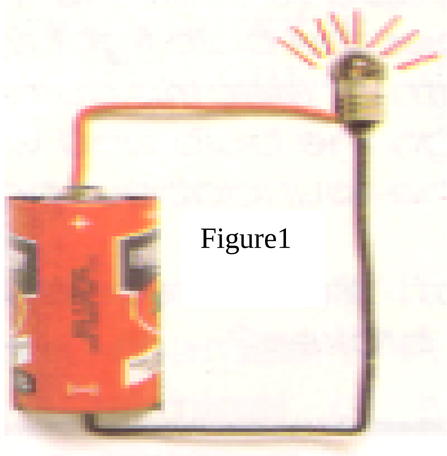
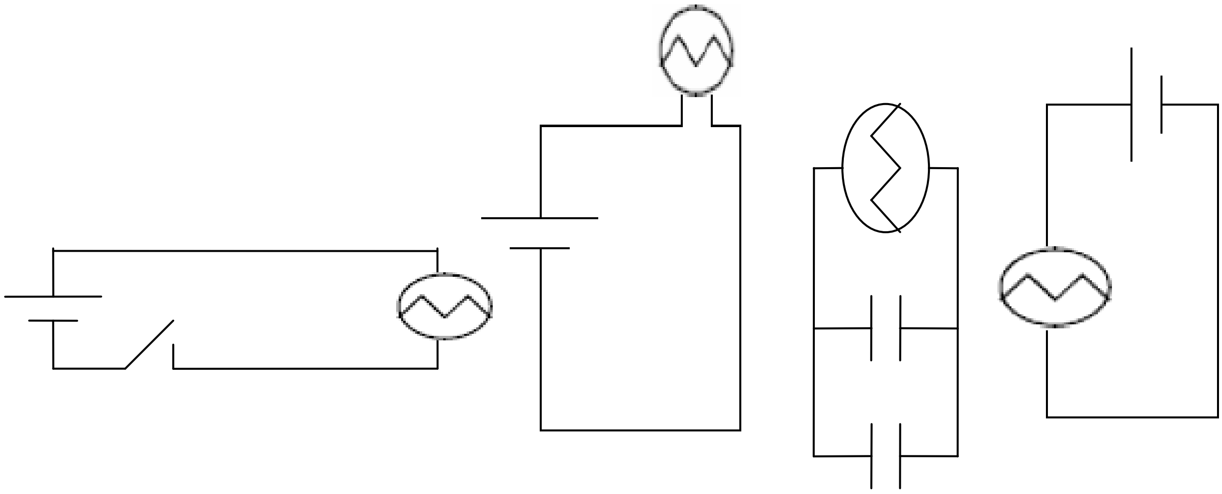


Figure1



A **B** **C** **D**

Appendix E
Student attitude Survey toward Science
(Sources: TIMSS, 1999; Century, 2002)

Student Name: .... School ....

Circle one answer per question

Item	*Strongly Agree*	*Agree*	*Disagree*	*Strongly Disagree*
1. It is important to do well in science at school	A	B	C	D
2. I usually do well in science at school	A	B	C	D
3. Science is difficult	A	B	C	D
4. I feel I am a lower achiever in science	A	B	C	D
To do well in science at school you need:	A	B	C	D
5. lots of natural (talent/ability)	A	B	C	D
6. good luck	A	B	C	D
7. I like science	A	B	C	D
8. I enjoy learning science	A	B	C	D
9. Science is boring	A	B	C	D
10. Science is an easy subject	A	B	C	D
11. Science is important to everyone's life	A	B	C	D
12. I would like a job that involved using science	A	B	C	D
13. Studying science makes me uncomfortable	A	B	C	D
14. I like doing experiments in science	A	B	C	D
15. I want to learn all I can about science	A	B	C	D
16. I like science better than before	A	B	C	D
17. I don't like to do any activities in science	A	B	C	D
18. Science lessons are my favourite	A	B	C	D

Appendix F
Teacher Performance Assessment Standards

The goal of the implementation of the Performance-Based Assessment Program is not simply to measure students' performance, but to improve it significantly. Therefore, the teacher participants are required to develop critical classroom assessment knowledge and skills besides what they are already expected to have master as in-service teachers. Thus, science teachers will be trained to master the following standards:

St.	Sub. St.	Items
1		Teachers should be skilled in designing and/or choosing an appropriate performance-based assessment task.
	1	Awareness of the difference between traditional and alternative assessment methods.
	2	Know the concept and some formats of performance-based assessment
	3	Know the components of performance-based assessment.
	4	Following appropriate criteria in designing or choosing performance-based assessment tasks.
	5	Considering the cultural, social and economic background of students.
2		Skills in developing strategies to integrate appropriate teaching styles with assessment methods to obtain highly valued learning outcomes.
	6	Skilled in assessing the result as well as the process, by using appropriate techniques such as inquiry, problem solving, concept-mapping.
	7	Skills in encouraging students to be more active in the classroom by following one of the constructivist approaches.
	8	Skills in using performance-based assessment in ways that encourage and motivate students to use higher order thinking skills.
	9	They should be skilled in using assessment as an instructional tool that promotes learning.
3		Skills in administering, scoring and interpreting the assessment result.
	10	They will administrate daily, weekly and term assessment for their classroom.
	11	Skills in interpreting informal and formal assessment results, including students' performance in class and on homework assignments.
	12	Ability o use rubrics for scoring variety y of performance-based assessment forms such as tasks, projects and portfolios.
	13	Skills in using observation techniques for continuous assessment purposes.
4		Skills in using assessment results for formative purposes.
	14	They will be skilled in providing opportunities for students to reflect upon their own growth in concepts, processes and attitudes
	15	Skills in involving students in the classroom process to take responsibility for and improve their own learning.
	16	Ability to use assessment results to modify their instructions in order to improve teaching strategies.
	17	Employing the assessment results to customise students learning.

Appendix G
Teacher Performance Assessment Questionnaire

<u>Choose one answer for each one of these questions</u>

1	The most important factor/s educators seek for alternative assessment is/are that, the traditional assessment methods: a. Do not reflect the outcomes that teachers focus on. b. Give partial information regarding what students know and what they are able to do. c. Are not effective in assessing students understanding of concepts. d. Focus on measuring low-level recall and recognition skills. e. All of the above.
2	The recent trends in assessment have been changed to: a. Emphasise complex skills. b. Emphasise individual assessment. c. Accumulate isolated facts and skills.
3	Performance-based assessment is a new form of alternative assessment which is characterised by: a. A high degree of reliability. b. Reflecting authentic situations. c. Being easy to correct.
4	Performance-based assessment requires the student to: a. Recall a specific body of knowledge about the proposed themes. b. Demonstrate higher-level thinking skills. c. Choose a correct response from the available options.
5	A portfolio is : a. A file that contains collections of a student's work, assembled over time. b. A type of alternative assessment. c. A record of all students' work. d. An assessment sheet of student oral presentations.
6	A holistic rubric requires assessors to : a. Assign a single score based on the overall quality or on one aspect of the student's response. b. Give separate ratings to different aspects of the work. c. None of the above.
7	The main components of performance-based assessment are: a. Performance task, rubric, response format. b. Performance task, key answers, questions. c. Questions, rubric, teacher sheet.
8	A science teacher was using performance-based assessment in his classroom in a normal lesson. He let the students discuss a task and solve it in groups. At the end of the lesson, he asked each student to try to

	remember what he did over the task time. The principal, who observed the lesson, criticised the teacher, because he: a. Let students discuss solving the task. b. Did not give them the response formats. c. Did not ask each group to present their work.
9	Whether designing or choosing a task, performance tasks should have the following feature: a. Develop thinking in a variety of styles. b. Focus on one style of thinking. c. Have one correct answer.
10	A science teacher designed a performance task and prepared its rubric, which determines the acceptable and unacceptable performance. When he should show students the rubric? a. Before students start work on the task. b. At the end of the task. c. After correcting their work.
11	A beginner science teacher tried to adapt a performance-based assessment task to suit his students. Which one of the following needs to be considered in an adapting task? a. The number of students in the class. b. The cultural context in which a task is formed. c. The time required for fulfilling the task. d. The method of correcting students' responses.
12,13	Determine which of these statements is inquiry and which is solving problem: Statement #1: _____ would start out by deciding what concept you wanted to explore. To ask a question: to figure out what observation you need to make to answer the question, to interpret your observations to create models that not only explain what you saw but predicted something else you might see. ▪ inquiry ▪ solving problem Statement # 2 _________ a process involving the application of knowledge and skills to achieve a goal when a solution method is not obvious to the learner. ▪ inquiry ▪ solving problem
14	Which of the following perspectives would be most consistent with a constructivist view of learning? a. Teach to the middle of the class to achieve the best results. b. Be sure that every student has the proper materials and is ready to work. c. Expect each student to process the lesson material somewhat differently. d. Use mnemonics and other devices to make learning as simple as

	possible.
15	A science teacher wants to assess his students' skill in organising ideas rather than just repeating facts. Which words should he use in formulating essay exercises to achieve this goal? a. Compare, contrast, criticise. b. Identify, specify, list. c. Order, match, select. d. Define, recall, restate.
16	A school principal was evaluating the teaching performance of Mr. Williams, the sixth grade teacher. One of the things the principal wanted to learn was if the students were being encouraged to use higher order thinking skills in the class. What documentation would be the most valid to help the principal to make this decision? a. Mr. Williams' lesson plans. b. The curriculum guides for sixth grade. c. Copies of Mr. Williams' unit tests or assessment strategies used to assign grades. d. Worksheets completed by Mr. Williams' students, but not used for grading.
17	In order to use assessment for improving students' learning, it should : a. Be part of effective planning of teaching and learning. b. Take into account the importance of learner motivation. c. Be recognised as central to classroom practice. d. All of the above.
18	Which of the following choices typically provides the most reliable student-performance information that a teacher might consider when assigning a unit grade? a. Scores from a teacher-made test containing two or three essay questions related directly to instructional objectives of the unit. b. Scores from a teacher-made 20 item multiple-choice test designed to measure the specific instructional objectives of the unit. c. Oral responses to questions asked in class of each student over the course of the unit. d. Daily grades designed to indicate the quality of in-class participation during regular instruction.
19	During the most recent grading period, a science teacher graded no homework and gave only one end-of-unit test. Grades were assigned only on the basis of the test. Which of the following is the major criticism regarding how he assigned the grades? a. The grades probably reflect a bias against minority students that exists in most tests. b. Decisions like grade assignment should be based on more than one piece of information. c. The test was too narrow in curriculum focus. d. There is no significant criticism of this method providing the test covered the unit's content.

20	Students' scores on standardised tests are sometimes inconsistent with their performance in classroom assessments (e.g., teacher tests or other in-class activities). Which of the following is **not** a reasonable explanation for such discrepancies? a. Some students freeze up on standardized tests, but they perform well in classroom assessments. b. Students often take standardized tests less seriously than they take classroom assessments. c. Standardised tests measure only recall of information while classroom assessments measure more complex thinking. d. Standardised tests may have less curriculum validity than classroom assessment.
21	A teacher gave three tests during a grading period and he wants to weight them all equally when assigning grades. The goal of the grading program is to rank order students on achievement. In order to achieve this goal, which of the following should be closest to equal? a. Number of items. b. Number of students taking each test. c. Average scores. d. Variation (range) of scores.
22	Mr. Klein bases his students' grades mostly on graded homework and tests. Mr. Kaplan bases his students' grades mostly on his observation of the students during class. A major difference in these two assessment strategies for assigning grades can best be summarised as a difference in a. Formal and informal assessment. b. Performance and applied assessment. c. Customised and tailored assessment. d. Formative and summative assessment.
23	Students in Mr. Jakman's science class are required to develop a model of the solar system for their end-of-unit grade. Which scoring procedure below is most reasonable for assessing these student projects? a. When the models are turned in, Mr. Jakman identifies the most attractive models and gives them the highest grades, the next most attractive get a low grade and so. b. Other teachers in the building are asked to rate each project on a 5 point scale based on their quality. c. Before the projects are turned in, Mr. Jakman constructs a scoring key based on the critical features of the projects as identified by the highest performing students in the class. d. Before the projects are turned in, Mr. Jakman prepares a model or blueprint of the critical features of the product and assigns scoring weights to these features. The models with the highest scores receive the highest grade.
24	A teacher wants to document the validity of the scores from a classroom assessment strategy she plans to use for assigning grades on a class unit. What kind of information would provide the best evidence for this

	purpose? a. Have other teachers judge whether the assessment strategy covers what was taught. b. Match an outline of the instructional content to the content of the actual assessment. c. Let students in the class indicate if they thought the assessment was valid. d. Ask parents if the assessment reflects important learning outcomes.
25	A teacher wants to make a plan for observing students' behaviours. Which of the following is suitable: a. Use observation to collect data on behaviours that are difficult to assess by other methods. b. Record observation during or soon after observing. c. Observe the way students solve problems and complete tasks. d. All of the above
26	Teachers use assessment information formatively when they: a. Analyse which students need more practice. b. Reflect on the effectiveness of their own teaching practices. c. Confer with students regarding their strengths and the areas that need improvement. d. All of the above
27	A science teacher is starting a new semester with a factoring unit in his science class. Before beginning the unit, he gives his students a test on the properties of electricity. Which of the following is the most likely reason he gives this test to his students? a. The principal needs to report the results of this assessment to the state testing director. b. He wants to give the students practice in taking tests early in the semester. c. He wants to check for prerequisite knowledge in his students before he begins the unit on electricity. d. He wants to measure growth in student achievement of these concepts, and scores on this test will serve as the students' knowledge baseline.
28	Self-assessment is a new assessment technique which allows students to: a. Control decisions regarding what will or won't be learned or tested. b. Assign their own grades in order to determine whether to stay or move up. c. Regulate their efforts and appraise the quality of their work. d. None of the above.
29	A teacher wants to make students more responsible for their learning. Which of the following most likely to achieve this goal? a. Making a rigorous system those students should follow in the classroom.

	b. Informing parents of misbehaviour by students. c. Giving students the opportunity to assess their work. d. Sending a student who shows irresponsible behaviour to the principal. e. None of the above.
30	The learning method that helps a student to increase his/her achievement and build a positive attitudes toward others is: a. Individual learning b. Competitive learning c. Cooperative learning

Appendix H
Interview questions

Teacher interview questions

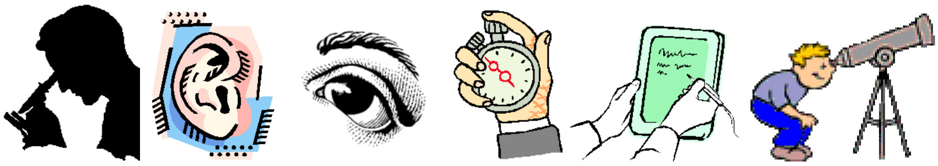
1. What are the main differences between the old (traditional assessment) and the new (performance assessment) methods?
2. What are the advantages and disadvantages of using the performance-based assessment approach?
3. What were the other difficulties faced whilst implementing performance-based assessment in your school?
4. How do you describe your attempt at using performance-based assessment in your classrooms?
5. How do you think students responded to implementing performance-based assessment?
6. Do you think the school facilities such as the laboratory and the library support the implementation of performance-based assessment in your school?
7. What role do you think the school community (particularly principals and teachers) played in the implementation of the performance-based assessment project?

Student interview questions

1. What are the differences in your science classes between this semester and the previous semester?
2. What do you think about the elements of the new method?
3. What are the most important things you like and dislike in studying science this semester?
4. Would you like to study science in the next semester in the same way as this semester? Explain your answer.

Appendix I
Examples of the main components of the Arabic version
(ملاحظة محتويات هذا الملحق لا تشتمل بالضرورة على كل محتويات البرنامج باللغة الانجليزية)

التعلم الفعال



في عالم اليوم لم يعد المربون يعطون الكثير من الأهمية لعمليات حفظ المعلومات واسترجاعها، وذلك لعدة أسباب فالمعلومات في أي مجال أصبحت أكثر من أن تحصى فضلا أن تحفظ كما أصبحت متاحة ومتيسرة لمن يريد الحصول عليها، وفوق ذلك فالمعلومات وخاصة في مجال العلوم في تطور دائم لذلك تركز اهتمام المربون بتطوير مهارات الفهم والإبداع لدى التلاميذ والاتجاه نحو إيجاد معرفة بناءة قابلة للتطبيق.

المعارف ومهارات التفكير اكتساب المعارف العلمية من خلال إتباع أسلوب الاستكشاف وحل المشكلات وما يتطلب ذلك من تعلم و ممارسة العديد من المهارات العقلية والتطبيقية .	▪ إتباع استراتيجيات الاستكشاف وحل المشكلات في تعلم العلوم لتحقيق ذلك ، الطالب سوف يقوم بـ: ▪ يثير أسئلة يمكن الإجابة عليها من خلال القيام بعملية استكشاف علمي. ▪ يستخدم خريطة ذهنية للتخطيط لعملية الاستكشاف وجمع وتسجيل المعلومات. ▪ يقوم بعملية ملاحظة دقيقة مستخدما الأدوات ووحدات القياس المناسبة. ▪ يقوم بعملية استقصاء علمي. ▪ التعرف على وجود أكثر من طريقة لحل المشكلة. ▪ يقوم عملية التقصي العلمي ويستخدم النتيجة لأغراض مفيدة ▪ يصمم، يبنى ، ويختبر جهاز أو وسيلة علمية مشكلة مطروحة ▪ ينمى بعض المهارات التطبيقية لدراسة العلوم: ▪ المهارات التطبيقية الأساسية: ▪ الملاحظة يقوم بملاحظة مقصودة بهدف جمع بيانات حول موضوع او حدث معين وتسجيل خصائصه أو التغيرات التي قد تطرأ عليه. ▪ التساؤل يطرح أسئلة لما يشاهد وكذلك يصوغ بعض الأسئلة التي يمكن التحقق من إجاباتها بشكل علمي .

▪ طرح فروض يطرح بعض الحلول أو التفسيرات المؤقتة لمشكلة أو ظاهرة معينة ليتأكد بعد ذلك من صحتها أو خطأها بالتجربة. ▪ التصنيف يفرز الأجسام او الموضوعات إلى مجموعات بناء على خصائص معينة او لأغراض محددة. ▪ القياس يستخدم وحدات القياس(كوحدة قياس الأطوال ، الأوزان أو الزمن) بشكل صحيح ومناسب ▪ الاتصال القيام بتقديم أو شرح ما توصل إليه من نتائج عن طريق الوسائل اللفظية أو الكتابية ويتضمن ذلك استخدام الرسوم التوضيحية كالرسوم والخرائط وكذلك مهارات التواصل مع الآخرين لتقديم عمل أو أداء مهمة ▪ استنتاج القدرة عل إيجاد تفسير منطقي بناء على ما تم مشاهدته. ▪ التنبوء القدرة على التوقع بوقوع خطوات لاحقة لحدث معين بناء على نتائج سابقة تم مشاهدتها أو استنتاجها ▪ استخدام التكنولوجيا القدرة على استخدام وسائل التكنولوجيا لأغراض علمية مفيدة كاستخدام الكمبيوتر كوسيلة علمية أو البحث عن معلومات محددة على الانترنت. ▪ مراعاة قواعد السلامة إتباع وتطبيق قواعد السلامة عند إجراء التجارب العلمية للحفاظ على السلامة الشخصية وسلامة الآخرين وكذلك الأدوات المستخدمة ▪ المهارات التطبيقية المركبة: ▪ التجريب تصميم وتنفيذ خطوات محددة للحصول على معلومات صادقة يمكن من خلالها تفسير العلاقة بين عناصر التجربة يتضمن التجريب العديد من المهارات التطبيقية الأساسية بحسب طبيعة التجربة. ▪ الاستطلاع:إعداد خطة لجمع المعلومات وتفسيرها	

2. الاتجاهات والقيم تطوير الاتجاهات والقيم الشخصية بشكل ايجابي نحو الذات والمجتمع وربطها بالقيم الدينة والاجتماعية للمجتمع السعودي.	▪ تكوين قيم ايجابية نحو الذات والاخرين: ▪ قبول مستوى متزايد من المسؤولية الذاتية للتعلم. ▪ التعود على تحمل قدر من المسؤولية تجاه الذات وتجاه الآخرين. ▪ اكتساب ذهنية شغوفة بالبحث والاستكشاف. ▪ يثمن المعرفة العلمية التي تم اكتسابها بعد بذل بعض الجهد والوقت. ▪ يربط الحقائق العلمية بالمفهوم الإسلامي للكون والحياة. ▪ يكون مفاهيم الأمانة والدقة العلمية ▪ يلتزم ويقدر طرق التفكير العلمي. ▪ يقدر طبيعة العمل الجماعي ▪ تكوين اتجاهات ايجابية نحو العلوم ▪ تنمية اهتمام وتطلع للقيام بتجارب وتقصي في الموضوعات العلمية. ▪ يقدر أهمية التعليمات للقيام بالتجارب العلمية. ▪ ينمى الإحساس بأهمية العلوم في حياتنا. ▪ تنمية حب الاستطلاع لدراسة الظواهر العلمية. ▪ الإقدام بشكل طوعي على قراءات الكتب والمواد الأخرى المرتبطة بالعلوم. ▪ البحث عن الدليل العلمي وتقدير أهميته في صياغة وطرح الاستنتاجات.
مهارات الاتصال	▪ يتعامل بشكل تعاوني كعضو فاعل في مجموعة ▪ يكون قادر على التواصل بشكل واضح مع فئات مختلفة من المستمعين ▪ يعمل لبناء علاقة ايجابية مع الآخرين ▪ يجيد مهارات الاستماع والملاحظة للحصول على معلومات وتفسيرها ▪ يستخدم أساليب مختلفة للتواصل مع المجتمع

التعلم التعاوني

طرائق إدارة الفصل

Office of Science & Math Education. (n.d., pp. 16-17). *GET A CHARGE*: Teacher's Guide: Illinois State Board of Education, from www.sciencemadesimple.com

تقوم فكرة التعلم التعاوني على إدماج التلميذ في نشاط مع واحد أو مجموعه من أقرانه للحصول على مخرجات تعليمية معينة، وتعتمد هذه الفكرة بشكل أساسي على بعض نظريات النمو والتعلم وخاصة نظرية بياجيه في النمو وجون ديوي في التعلم فبياجيه يرى أن التفاعل بين الأطفال يؤثر على نموهم المعرفي والأخلاقي، فالطفل يصبح اقل تمركزا حول ذاته وأكثر إدراكا لطبيعة الاختلاف في وجهات النظر عندما يواجهه من أقرانه أثناء النقاش وإبداء وجهات نظر متباينة (Tudge & Caruso, 1989).

وفيما يلي بعض القواعد التى ينصح بإتباعها عند استخدام هذه الطريقة:

1- **لكي يؤدي تلاميذك النشاط الصفي بنجاح ، من المهم أن يعرفوا ويتبعوا العشر القواعد التالية لعمل المجموعة:**

- **التحرك إلى المجموعة بهدوء ودون إزعاج الآخرين**
- **التحدث بصوت هادي**
- **البقاء مع المجموعة وعدم الانتقال منها إلى أخرى بدون إذن**
- **كل تلميذ يسند إليه مهمة معينة**
- **كل تلميذ يشترك في أداء العمل الكلي**
- **لا احد يفرض رأيه على بقية أعضاء المجموعة**
- **الأدوات مشاعة بين أعضاء المجموعة**
- **كل يشارك بأفكاره**
- **اخذ الدور للحديث أو إبداء الرأي**
- **احترام أعضاء المجموعة وعدم التقليل من آرائهم أو مشاركاتهم**

2- **تجنب المنافسة بين المجموعات ويمكن تحقيق ذلك من خلال انتقاء أعضاء كل مجموعة بأحد أساليب الاختيار العشوائي، عن طريق أرقامهم بالسجل مثلا أو عن طريق قدراتهم بحيث يوزع التلاميذ الاوائل على المجموعات وأي كانت الطريقة، يجب أن يكون التلاميذ على دراية بأنه إذا لم يكن أداءهم داخل المجموعة مناسبا فان طرقا أخرى قد تتخذ .**

3. **عرف بوضوح المهمة المطلوب أداءها من المجموعة**

4. **تأكد من وجود منتج أو عمل يرتبط بنشاط المجموعة**

5. **لتحديد وقت عمل المجموعة أو النشاط حدد وقت قصير لإنجاز العمل بدلا من إطالة الوقت.**

6. **كل عضو في المجموعة يجب أن يضطلع بدور، توزيع الأدوار بانتظام يجب أن يتم لإعطاء كل تلميذ الفرصة للقيام بدور مختلف الأدوار التي يقوم بها التلاميذ يمكن أن تتضمن :**

- **قائد المجموعة هذا الشخص يقوم بضمان عمل أعضاء المجموعة للمهمة ، التأكد من أن النشاط قد تم استيعابه و فهم واستكمل من كافه أعضاء المجموعة أي سؤال يمكن مناقشته حالا مع المدرس.**

- مسئول الأدوات هذا الشخص يوفر الدعم المطلوب للمجموعة إذا كانت المجموعة كبيرة بما فيه الكفاية يمكن أن يعين مسئول أخر يتكفل بإعادة الأدوات إلى مكانها المخصص ويتأكد من تنظيف المجموعة لمكان عملها
- مسجل التقويم هذا الشخص يسجل الاستجابات التي صاغها الأعضاء أيضا يلاحظ كيف أعضاء المجموعة يؤدون مسؤولياتهم ومساهماتهم في الأداء الكلي و مخرجات المجموعة.
- المقرر هذا الشخص يكتب التقرير الختامي للمجموعة لتقديمه أمام المجموعات الأخرى التقرير ربما يتطلب كتابة بيانات المجموعة في لوحة الصف.إذا كان المجموعة كبيرة يمكن أن يتقاسم المهام اثنان من الطلبة ويقومان بتقديم نتائج المجموعة أمام الصف.

7. إتباع الخمس تعليمات التالية لتحقيق متعه وأمان أكثر بالا نشطه:

- الحيطة والحذر مجموعة العمل في المعمل تتطلب الحذر في كل خطوه تعليمات السلامة يجب أن تتبع وكذلك قائمة مراجعة بنود السلامة يجب أن تطبق قبل إجراء أي نشاط.
- التعاون لضمان نجاح عمل المجموعة كل الأعضاء يجب أن يتعاونوا فيما بينهم .
- المساهمة كل عضو يجب أن يساهم في أداء المجموعة
- الضبط مجموعة العمل تتطلب التحكم في كل إعمالها الصوتية والحركية لتجنب التشويش داخل الصف ، الضبط يجب أن يطبق من كل عضو في المجموعة.
- تنظيف مكان العمل كل عضوا في المجموعة يجب أن يترك مكان العمل نظيفا بعد أداء النشاط الطلبة داخل المجموعة يجب أن يتأكدوا بأن مكان عملهم مرتب وان كل الأدوات أعيدت إلى مكانها المخصص.

الفصل التاسع الكهرباء

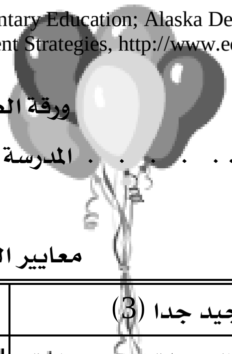
ن	أهداف تدريس الفصل
1	بعد تدريس هذا الفصل يتوقع أن يتمكن التلاميذ من أن : يشحن الأجسام بالدلك
2	يبين بالتجربة أن الشحنات الموجبة تتنافر والمختلفة تتجاذب
3	يعين مصادر التيار الكهربائي
4	يشرح مكونات الخلية الجافة .
5	يكون دائرة كهربائية بسيطة
6	يكون دائرة كهربائية بالطريقتين التسلسلية والمتوازية
7	يصف بعض المواد بناء على نتائج تجريبية إلى مواد موصلة وعازلة للكهرباء
8	يتعرف على وظيفة المفتاح في الدائرة الكهربائية
9	التعرف على فوائد الكهرباء
10	يستخدم بعض المصطلحات المرتبطة بالكهرباء
11	يتبع جوانب السلامة عند التعامل مع الكهرباء
12	يولد التيار الكهربائي عمليا باستخدام ملف ومغناطيس

وحدة الكهرباء

نشاط رقم1

شحن الأجسام بالكهربائية

Adapted from: Peters & Gega (2002), Science in Elementary Education; Alaska Department of Education & Early Development, A collection of Assessment Strategies, http://www.educ.stste.ak.us.



ورقة الطالب

الاسم.................................. **المدرسة**..................................

معايير التقويم

ممتاز (4)	جيد جدا (3)	جيد(2)	يحتاج إلى تحسن (1)
استخدم الملاحظة لفهم عملية التجاذب بين جسمين أجاب بشكل صحيح على كل الأسئلة قدم تفسيرا مناسبا لما شاهد بين من خلال عمله فهما عميقا لمفهوم الكهرباء الساكنة.	استخدم الملاحظة لفهم عمليّة التجاذب بين جسمين.أجاب على معظم الأسئلة بشكل صحيح قدم تفسيرا صحيحا لحد ما لما قام بمشاهدته بين من خلال عمله قدرا من الفهم لمفهوم الكهرباء الساكنة	قام بعملية الملاحظة لفهم عملية التجاذب بين جسمين.أجاب على بعض الأسئلة بشكل صحيح قدم بعض التفسيرات المرتبطة بما تم ملاحظته بين القليل من الفهم لمفهوم الكهرباء الساكنة .	معظم عمله غير صحيح ولا يرتبط بموضوع النشاط. إجابات فارغة

__________تواصل مع المعلم بشكل مناسب.

__________شارك في أداء النشاط مع زملائه

__________أكمل نموذج التقويم الذاتي

__________استخدم الأدوات بشكل مناسب

__________اظهر قدر من المسؤولية تجاه نفسه وتجاه الآخرين.

ملاحظات المعلم

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وحدة الكهرباء

نشاط رقم1

يصاب بعض الناس بوخزه كهربائي عندما يحاول فتح باب المنزل أو باب السيارة وق يتكرر ذلك دون أن يعرف كثير من الناس سبب ذلك.

المطلوب منك في هذا النشاط أن تفسر لماذا تحدث مثل هذه الوخز الكهربائيه.

وسوف يعينك على ذلك القيام بالتجربة التالية:

المواد قطعه قماش صوف، ورقه، مشط أو مسطره .

الإجراءات:

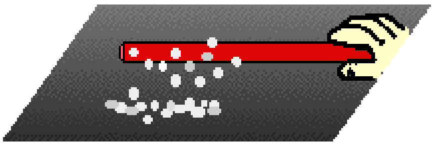
ماذا تتوقع يحدث عندما تقرب المسطرة من قصاصات الورق؟

اكتب

توقعاتك. ....

قطع الورقة إلى قصاصات صغيرة ثم قرب المسطرة منها ماذا حدث؟

أدلك المسطرة بقطعة الصوف عدة مرات، ثم قربها من قصاصات الورق، ماذا تلاحظ



4-ناقش مع مجموعتك التفسير المحتمل للمشكلة التي عرضت عليك في البداية ، ثم سجل التفسير النهائي الذي تراه مناسبا

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تقويم ذاتي
ما شعورك حول هذا النشاط؟   -
هل ترغب أن تعمل مثل هذا النشاط مره أخرى؟   -

هل ترشح إدراج هذا النشاط في المحفظة نعم ☐ لا ☐

وحدة الكهرباء

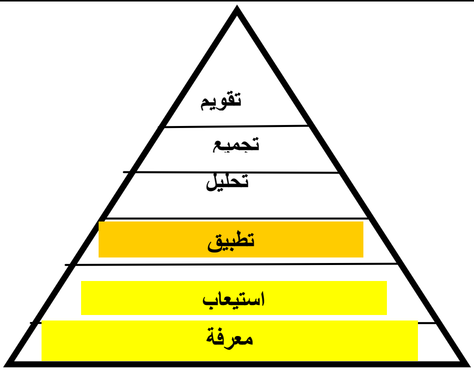
نشاط رقم 1

نشاط إضافي

كرر التجربة السابقة مستخدما أدوات أخرى كقلم من البلاستك أو ساق من الزجاج وسجل مشاهداتك

نشاط رقم 1

ورقة المعلم

التعلم الفعال	 أ- يركز هذا النشاط على تحقيق المخرجات التالية 1- مهارات المعرفة والتفكير: • تطبيق تجربه • الملاحظة • تنبوء • استنتاج المحتوى المعرفي للنشاط: • يبين بالتجربة أن بعض الأجسام يمكن شحنها بالدلك. ب- يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية: • تنمية اهتمام التلميذ وتطلعه للقيام بتجارب وتقصي في الموضوعات العلمية. • اكتساب ذهنية شغوفة بالبحث والاستكشاف
الوقت	20- 30 دقيقه
خلفية المعلم عن النشاط	كل ذره تتكون من بروتونات، نيترونات والكترونات البروتون يحمل شحنات موجبة(+) و الالكترون يحمل شحنات سالبة، والنيوترون متعادل (لا يحمل شحنات) البروتونات والنيوترونات مرتبطين ببعضهم بقوه داخل النواة، بينما الالكترونات يمكن أن تنتقل من ذره إلى أخرى بعدة طرق ، منها الطريقة التى يتناولها النشاط الحالي عن طريق الدلك.
وصف النشاط	في هذا النشاط سوف يقوم الطلبة باستخدام أدوات بسيطة مثل المشط أو المسطرة لملاحظة كيف يمكن شحن المواد بالدلك لتجذب بعض المواد التلاميذ سوف يعملون في مجموعات حسب طريقه عمل المجموعات(انظر التعليم التعاوني) لمدة عشر دقائق ثم يجيب كل منهم على الاسئله وجدول التقويم الذاتي في آخر عشر دقائق ناقش مع الطلبة إجاباتهم للتأكد من تحقيق أهداف النشاط
عمل النشاط	في مجموعات
محددات الإجابة	يفترض أن تعطيك محددات الإجابات التي يتم تقويم الطالب على أساسها وكذلك تقويم الطالب لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات الطلاب
إعطاء الطالب عمل إضافي	خلال قيامك بملاحظة التلاميذ أثناء قيامهم بالنشاط ومتابعة ا داؤه م يمكن أن تحصل على فكره مبدئية عن تقدمهم لذلك تقويم أداء التلاميذ على (محددات الإجابة) سوف تكون أيسر أي تلميذ يحصل على تقدير(جيد) أو اقل ينصح بإعطائه فرصه لتحسين عمله عن طريق طلب كتابه تقرير عن النشاط أو إعطائه واجب إضافي يساعده على فهم الموضوع او بكلا الاجرائين أما الطالب الذي ينتهي من عمله مبكرا فينصح بإعطائه نشاط إضافي

وحدة الكهرباء

نشاط رقم2

الكهرباء الساكنة الشحن بالدلك

Adapted form: Office of Science & Math Education (n.d.), *Get A Charge*: Illinois State Board of Education, from www.sciencemadesimple.com

ورقة الطالب

الاسم.. .... ***المدرسة*** ....

معايير التقويم

ممتاز (4)	جيد جدا(3)	جيد (2)	يحتاج إلى تحسن(1)
استخدم الملاحظة لفهم عملية التنافر بين جسمين أجاب بشكل صحيح على كل الأسئلة قدم تفسيرا مناسبا لما شاهد بين من خلال عمله فهما عميقا لمفهوم الكهرباء الساكنة. .	استخدم الملاحظة لفهم عملية التنافر بين جسمين.أجاب على معظم الأسئلة بشكل صحيح قدم تفسيرا صحيحا لحد ما لما قام بمشاهدته بين من خلال عمله قدر من الفهم لمفهوم الكهرباء الساكنة	قام بعملية الملاحظة لفهم عملية التنافر بين جسمين أجاب على بعض الأسئلة بشكل صحيح قدم بعض التفسيرات المرتبطة بما تم ملاحظته بين القليل من الفهم لمفهوم الكهرباء الساكنة .	معظم عمله غير صحيح ولا يرتبط بموضوع النشاط. إجابات فارغة

________تواصل مع المعلم بشكل مناسب.

________شارك في أداء النشاط مع زملائه

________أكمل نموذج التقويم الذاتي.

________استخدم الأدوات بشكل مناسب

________اظهر قدر من المسؤولية تجاه نفسه وتجاه الآخرين.

ملاحظات المعلم

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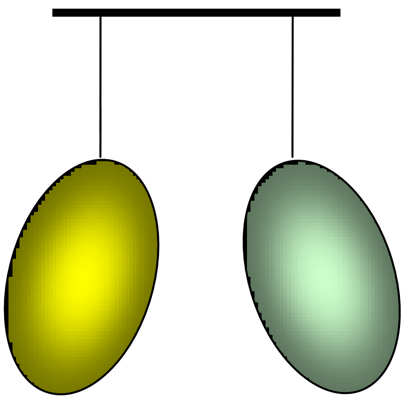
نشاط رقم 2

ينشأ عن الكهرباء الساكنة ظاهرتان هما التجاذب والتنافر.
كيف تحدث هاتان الظاهرتان؟ وما سبب حدوثهما؟
هذا ما سوف تتعرف عليه عند قيامك بالنشاط التالي



المواد

* بالونان
* قطعة قماش صوف، قطعة قماش حرير
* خيطان بطول 60 سم تقريبا

الفروض(ماذا تتوقع أن تتوصل إليه من التجربة؟):

❖ **أتوقع أن دلك إحدى البالونين بقطعة الصوف سوف يؤدى إلى**................. ....

❖ **أتوقع أن دلك كلا البالونين بقطعة الصوف سوف يؤدي إلى**.......................

الإجراءات:

1- انفخ البالونين واربط كل منهما بطرف خيط طوله 60 سم تقريبا.

2- اشحن احد البالونين بقطعة الصوف وعلقهما من وسط الخيط ولاحظ ماذا يحدث:

سجل ملاحظاتك:

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3- أدلك كلا البالونين بقطعة الصوف

ماذا حدث

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....

4- هل ملاحظاتك تتفق مع افتراضاتك؟

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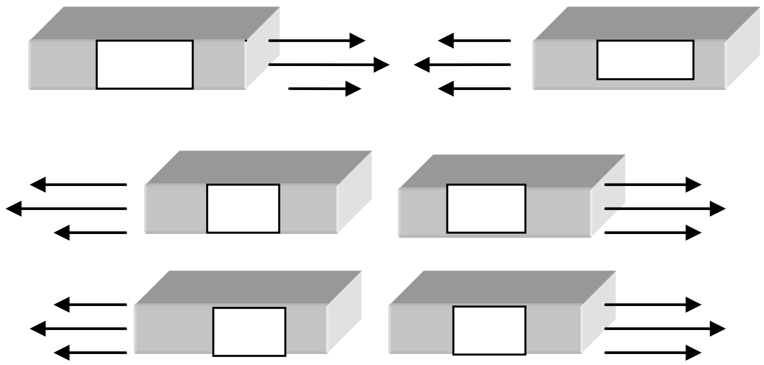
5- اكتب داخل كل صندوق نوع الشحنة التي تجعل الصندوقين يتجاذبان أو يتنافران حسب

اتجاه الأقواس وفسر إجابتك



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6 اكتب تقريرا مختصرا عن التجربة

- أ الهدف من التجربة

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-ب ماذا قمت به

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جـ النتائج التي توصلت إليها

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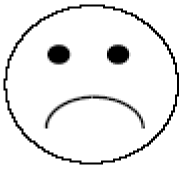
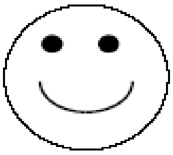
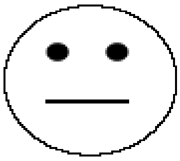
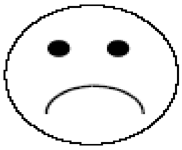
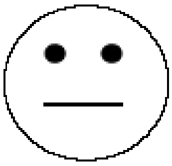
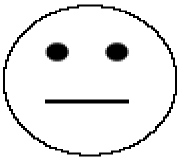
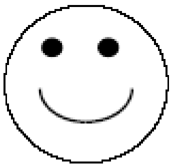
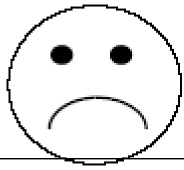
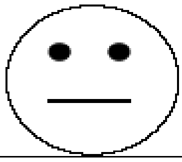
التقويم الذاتي

اتبعت إجراءات إجراء التجربة			
أكملت كتابة الفروض			
أستطيع أن اشرح الآن لماذا يحدث التنافر أو التجاذب بين الأجسام بالدلك			
اشتركت مع المجموعة في إجراء التجربة			
شعوري نحو هذا النشاط			

إذا واصلت العمل في هذا النشاط سوف أحاول أن أفهم

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أفضل شي تعلمته من هذا النشاط هو

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أنا أحببت الأنشطة التي قمت بها هذا الأسبوع	كثيرا ☐	لحد ما ☐	لم تعجبني ☐
أنشطة هذا الأسبوع كانت	صعبة جدا ☐	مناسبة ☐	سهلة جدا ☐
تعلمت من أنشطة هذا الأسبوع	الكثير ☐	بعض الأشياء ☐	القليل ☐

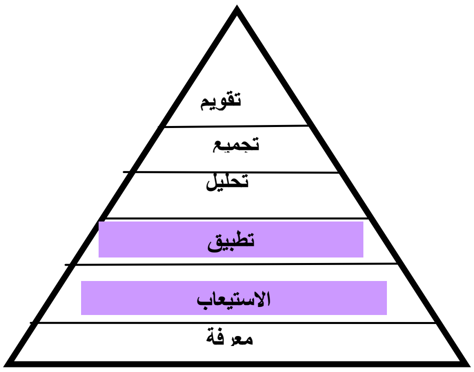
هل ترشح إدراج هذا النشاط في محفظة التقويم نعم ☐ لا ☐

بين لماذا ....

النشاط رقم 2

الكهرباء الساكنة الشحن بالدلك

ورقة المعلم

التعلم الفعال	**-أ يركز هذا النشاط على تعليم المعارف والمهارات التالية** **1- مهارات المعرفة والتفكير:** • كتابه فروض علمية • تطبيق تجربه • الملاحظة • كتابة تقرير عن تجربة **المحتوى المعرفي للنشاط:** • يثبت بالتجربة أن الشحنات المختلفة تتجاذب والمتشابهة تتنافر  ***ب يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية :*** • تنمية اهتمام التلميذ وتطلعه للقيام بتجارب علميه . • البحث عن الدليل العلمي وتقدير أهميته في صياغة وطرح الاستنتاجات
الوقت	20- 30 دقيقة
خلفية المعلم عن موضوع النشاط	طبيعيا الذرة تحتوى على عدد متساوي من الالكترونات ذات الشحنة السالبة (-) والبروتونات ذات الشحنات الموجبة (+) عملية الاحتكاك بين جسمين يجعل الالكترونات تنتقل من جسم إلى آخر، وفي هذه الحالة يحمل الجسم الذي تنتقل إليه الالكترونات شحنات سالبه أكثر بينما الجسم الذي انتقلت منه يحمل شحنات موجبه أكثر وحالة عدم الاتزان هذه تسبب التجاذب بين الأجسام التي تحمل شحنات مختلفة والتنافر بين الأجسام التي تحمل شحنات متشابهة الكهرباء الناجمة عن عملية الدلك تسمى الكهرباء الساكنة
وصف النشاط	في هذا النشاط الطلبة سوف يتحققوا باستخدامهم لبالونات من مفهوم عملية التجاذب و التنافر بين الأجسام عند دلكها في البداية يجب أن يفترض الطالب ماذا يحدث للبالونين عند شحن إحداهما وكذلك كلاهما بقطعة صوف ثم بعد ذلك يشرعوا في إجراء التجربة ليقارن بعد ذلك كل طالب من افتراضاته ومشاهداته ليصل بذلك إلى مفهوم العلاقة بين عملية التنافر/التجاذب و نوع الشحنة الكهربائية
عمل النشاط	يفضل إجراء التجربة بشكل زوجي (اثنان من التلاميذ) أو في مجموعات
نشاط إضافي	Extension I
واجب إضافي	EHW2

وحدة الكهرباء

نشاط رقم3

صنع مولد كهربائي

Adapted from: Council of Chief State School Officers (CCSSO), More Power to You, http://pals.sri.com/tasks/5-8/Morepower/directs.html

ورقة الطالب

الاسم. . . . . المدرسة . . . .

معايير التقويم

ممتاز	جيد جدا	جيد	يحتاج إلى تحسن
قام بتنفيذ كافة خطوات التجربة على الوجه المطلوب سجل مشاهداته في كافة خانات الجدول بشكل صحيح وصف من خلال التجربة العلاقة الحقيقية بين سرعة تحريك المغناطيس ومرور التيار الكهربائي في السلك حدد اتجاهات ابرة المغناطيس عند تحريك كل من قطبي المغناطيس داخل القضيب المجوف	قام بتنفيذ معظم خطوات التجربة على الوجه المطلوب سجل مشاهداته في معظم خانات الجدول بشكل صحيح وصف بشكل جزئي العلاقة الحقيقية بين سرعة تحريك المغناطيس ومرور التيار الكهربائي في السلك حدد جانب من اتجاهات ابره المغناطيس عند تحريك كل من قطبي المغناطيس داخل القضيب المجوف.	قام بتنفيذ بعض خطوات التجربة على الوجه المطلوب سجل مشاهداته في بعض خانات الجدول بشكل صحيح وصفه غير دقيق للعلاقة بين سرعة تحريك المغناطيس ومرور التيار الكهربائي في السلك لم يحدد بشكل واضح الأثر الفعلي لتحريك كل من قطبي المغناطيس داخل القضيب المجوف على اتجاه ابره المغناطيس.	معظم عمله غير صحيح ولا يرتبط بموضوع النشاط. إجابات فارغة

___________تواصل مع المعلم بشكل مناسب.

___________شارك في أداء النشاط مع زملائه

___________أكمل نموذج التقويم الذاتي

___________اتبع كل التعليمات.

___________استخدم الأدوات بشكل مناسب

___________اظهر قدر من المسؤولية تجاه نفسه وتجاه الآخرين.

ملاحظات المعلم

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نشاط رقم 3

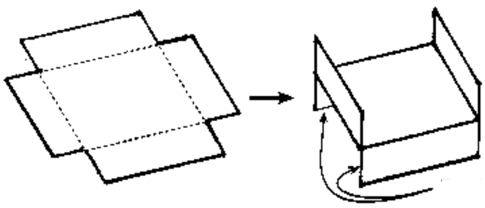
صنع مولد كهربائي

يمكن الحصول على الكهرباء من عدة مصادر منها البطارية والطاقة الشمسية بالإضافة إلى المولد الكهربائي يعتبر المولد الكهربائي من أهم مصادر توليد الكهرباء في هذا النشاط سوف تتعرف على الفكرة الأساسية التي يقوم عليها المولد الكهربائي .

الأدوات

1 بوصلة
2 قطعة ماسورة من الكرتون
3 قطعة كرتون
4 سلكين من النحاس بمقابض
5 قضيب مغناطيس قوي
6 شريط لاصق

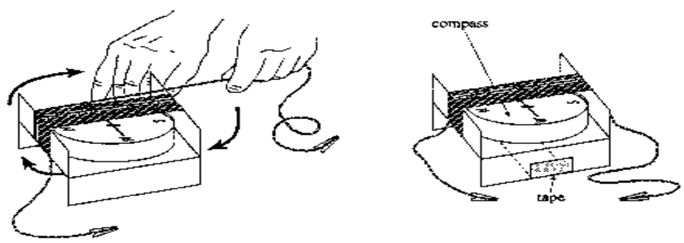
(ملاحظة هامة ضع المغناطيس بعيدا عن البوصلة)



شكل رقم (1)

خطوات التجربة:

1 أثنى طرفي الكرتون كما هو موضح في الشكل رقم (1) .



Figures B and C

17

2 أثنى طرفي الكرتون الآخرين وضع البوصلة ثم لف عليهما السلك كما هو موضح في الشكل التالي.
3 لصق احد طرفي الكرتون واسحب اللاصق إلى الطرف الآخر لتثبيت قاعدة الكرتون.
4 كون (ملف) عن طريق لف السلك الثاني على ماسورة من الكرتون حوالي 50 لفة مع ترك حوالي 15 سم من كل طرف كما هو موضح في الشكل التالي.

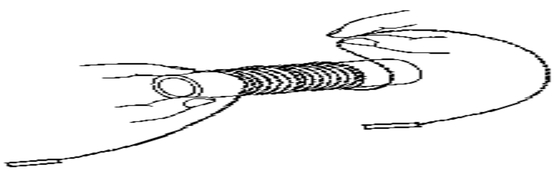
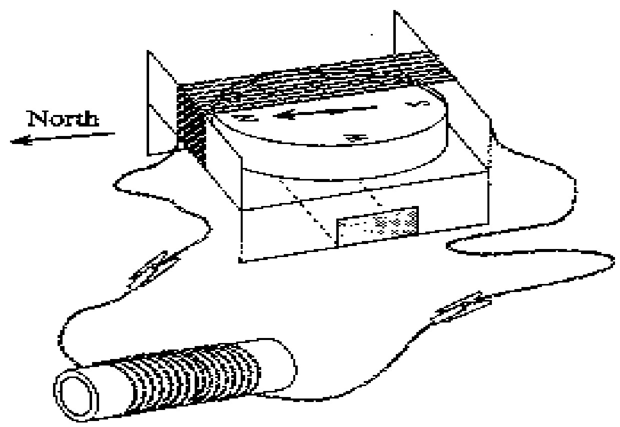
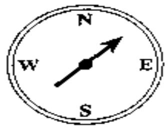


Figure D

5 وصل الأسلاك كما هو موضح في الشكل التالي مع مراعاة وضع اتجاه البوصلة نحو الشمال

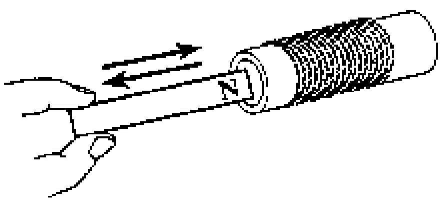


ملاحظة : قبل قيامك بإجراء التجربة ابعد المغناطيس عدة أمتار عن البوصلة وتأكد من أن اتجاه إبرة البوصلة باتجاه الشمال.بعد ذلك وخلال كل محاولة لاحظ اتجاه إبرة البوصلة هل تنحرف من الشمال إلى الغرب أم من الشمال إلى الشرق على سبيل المثال إبرة البوصلة في الشكل(4) انحرفت من الشمال إلى الشرق، ثم سجل ذلك في جدول البيانات.



إجراء التجربة:

أ) باستخدام القطب الشمالي كما في الشكل ، قم بالمحاولات التالية:



المحاولة الأولى :ضع القطب الشمالي للمغناطيس فقط عند حافة الماسورة .

المحاولة الثانية:ادخل المغنطيس ببطء داخل الماسورة ثم توقف بعد ذلك اخرج المغنطيس ببطء أيضا من داخل الماسورة كرر ذلك ببطء.

المحاولة الثالثة:اعد المحاولة رقم (2) ولكن بحركة أسرع ، كرر ذلك عدة مرات .

ب) باستخدام القطب الجنوبي. قم بالمحاولات التالية:

المحاولة (4) قرب القطب الجنوبي من الماسورة ثم توقف.

المحاولة (5) ادخل المغنطيس ببطء داخل الماسورة ثم توقف بعد ذلك اخرج المغنطيس ببطء من داخل الماسورة كرر ذلك ببطء.

المحاولة(6) اعد المحاولة رقم (5) ولكن بحركة أسرع ، كرر ذلك عدة مرات .

جدول البيانات				
المحاولة	اتجاه القطب المدخل في الماسورة	حركة المغناطيس	اتجاه انحراف إبرة البوصلة	
			عند إدخال المغناطيس في الماسورة	عند إخراج المغناطيس من الماسورة
1	ش	بلا حركه		
2	ش	ببطء		
3	ش	بسرعة		
4	ج	بلا حركه		
5	ج	ببطء		
6	ج	بسرعة		

اجب عن الأسئلة التالية:

1 بناء على النتائج التي توصلت إليها، صف العلاقة بين :

أ) سرعة تحريك المغنطيس و مرور التيار الكهربائي في السلك:

ب) اتجاه قطبي المغناطيس (الشمالي ا الجنوبي) داخل الماسورة واتجاه انحراف إبرة البوصلة

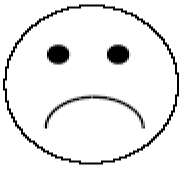
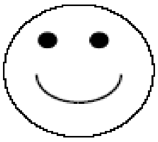
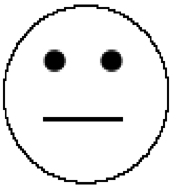
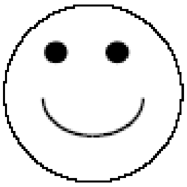
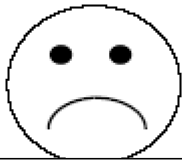
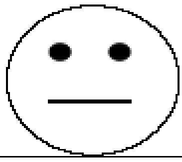
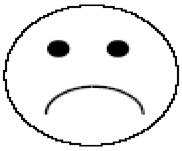
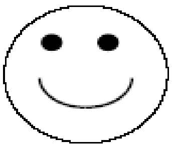
وحدة الكهرباء

نشاط رقم 3

نشاط إضافي

افترض انك تعيش بقرب مصب مائي كشلال أو نهر ولديك الأدوات التالية سلك نحاسي عجلة بحواف وقطعة مغناطيس صف مع الرسم كيف يمكنك استخدام هذه الأدوات لإنتاج تيار كهربائي

التقويم الذاتي

قمت بإجراء كل خطوات التجربة			
سجلت ملاحظاتي على التجربة في الجدول			
أستطيع أن اشرح طريقة توليد تيار كهربائي باستخدام ملف ومغناطيس			
اشتركت مع المجموعة في إجراء التجربة			
شعوري نحو هذا النشاط			

إذا واصلت العمل في هذا النشاط سوف أحاول أن افهم

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أفضل شي تعلمته من هذا النشاط هو

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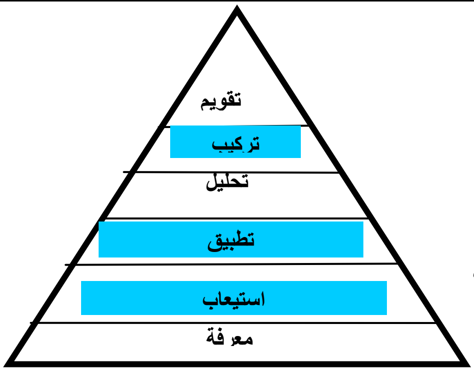
وحدة الكهرباء

نشاط رقم (3)

ورقة المعلم

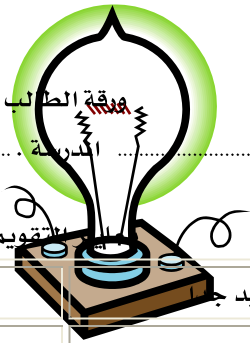
<table>
<tr><td>التعلم الفعال</td><td>أ - يركز هذا النشاط على تعليم المعارف والمهارات التالية
1- مهارات المعرفة والتفكير:
▪ تطبيق تجربة
▪ ملاحظة
▪ استنتاج
2- المحتوى المعرفي للنشاط:
* أن يولد الكهرباء عمليا باستخدام ملف ومغناطيس .
ب- يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية:
* أن يقدر التلميذ أهمية التعليمات للقيام بالتجارب العلمية
* تنمية حب الاستطلاع لدراسة الظواهر العلمية

</td></tr>
<tr><td>الوقت</td><td>30- 45 دقيقه</td></tr>
<tr><td>وصف النشاط</td><td>في هذا النشاط سوف يقوم التلاميذ بتوليد الكهرباء بإتباع الخطوات المبينة في ورقة الطالب .</td></tr>
<tr><td>كيفية القيام بالنشاط</td><td>• قسم الطلبة إلى مجموعات
• وزع الأدوات و أوراق النشاط بين الطلاب
• اطلب من كل مجموعة أن تنفذ بدقة تعليمات إجراء التجربة.
• تابع أداء التلاميذ للنشاط و سجل ملاحظاتك على أداءهم
• ساعد المجموعة التي تخلفت في أدائها بشكل غير مباشر عن طريق طرح بعض الاسئله عليهم.
• أعط كل طالب 5 دقائق في نهاية الوقت ليستكمل إجاباته ويكتب التقرير الذاتي.
• ناقش معهم فيما تبقى من الوقت إجاباتهم ثم اجمع أوراقهم ووزع عليهم الواجب</td></tr>
<tr><td>إعداد التلاميذ للنشاط</td><td>اطلب من كل طالب إحضار أدوات النشاط قبل يوم من إجرائه</td></tr>
<tr><td>عمل النشاط</td><td>في مجموعات</td></tr>
<tr><td>محددات الإجابة</td><td>يفترض أن تعطيك محددات الإجابات التي تقوم الطالب على أساسها وكذلك تقويم الطالب لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات الطلاب</td></tr>
<tr><td>إعطاء الطالب عمل إضافي</td><td>خلال قيامك بملاحظة التلاميذ أثناء قيامهم بالنشاط ومتابعة ا داؤه م يمكن أن تحصل على فكره مبدئية عن تقدمهم لذلك تقويم أداء التلاميذ على (محددات الإجابة) سوف تكون أيسر أي تلميذ يحصل على تقدير(مرضي) أو اقل ينصح بإعطائه فرصه لتحسين عمله عن طريق طلب كتابه تقرير عن النشاط أو إعطائه واجب إضافي يساعده على فهم الموضوع أو بكلا الاجرائين الطلب الذي ينتهي من عمله مبكرا فينصح بإعطائه نشاط إضافي.</td></tr>
</table>

وحدة الكهرباء

نشاط رقم4

الدائرة الكهربائية

Adapted from: Brown & Shavelson, Assessing Hands-On Science (1996); Office of Science & Math Education (n.d.), *Get A Charge*: Illinois State Board of Education, from www.sciencemadesimple.com



ورقة الطالب

الاسم .... الدرجة ....

التقويم

ممتاز	جيد جدا	جيد	يحتاج إلى تحسن
قام بتكوين دائرة كهربائية بشكل صحيح أضاف بنجاح قاطع للدائرة الكهربائية التي شكلها استنتج طريقة عمل القاطع الكهربائي كتب تقريرا واضحا وكاملا عن التجربة اظهر من خلال كتابته للتقرير فهما كاملا لمكونات الدائرة الكهربائية وطريقة عملها	قام بتكوين دائرة كهربائية بشكل صحيح أضاف بنجاح قاطع للدائرة الكهربائية التي شكلها وضح لحد ما طريقة عمل القاطع الكهربائي كتب تقريرا كاملا عن التجربة مع بعض الأخطاء اظهر من خلال كتابته للتقرير فهما لمكونات الدائرة الكهربائية وطريقة عملها	قام بتكوين دائرة كهربائية بشكل صحيح أضاف بصعوبة قاطع للدائرة الكهربائية التي شكلها لم يتعرف على النحو المطلوب طريقة عمل القاطع الكهربائي.لم يكمل كتابة التقرير عن التجربة مع وقوعه في بعض الأخطاء للجزء الذي كتبه اظهر من خلال النشاط فهما محدودا لمكونات الدائرة الكهربائية وطريقة عملها	معظم عمله غير صحيح ولا يرتبط بموضوع النشاط إجابات فارغة.

___________تواصل مع المعلم بشكل مناسب.

___________شارك في أداء النشاط مع زملائه

___________تبادل المعلومات مع زملائه

___________أكمل نموذج التقويم الذاتي.

___________استخدام الأدوات بشكل مناسب

___________اظهر قدر من المسؤولية تجاه نفسه وتجاه الآخرين.

ملاحظات المعلم

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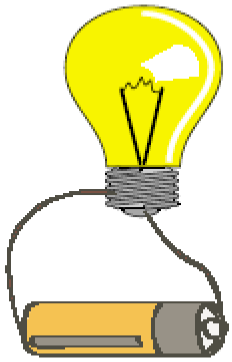
الدائرة الكهربائية

أنعم الله علينا بالكهرباء لاستخدامها لأغراض مختلفة، لعل من أهمها نعمة الإضاءة لاستخدامها في المنازل والمدارس والسيارات وغير ذلك . ولكن كيف تحدث الإضاءة ؟ ما أهم العناصر الأساسية للدائرة الكهربائية ؟ وكيف يمكن التحكم فيها؟ هذا ما سوف تتعرف عليه من القيام بالنشاط التالي



المواد بطارية جافه ، مصباح وسلكا نحاسيا

الإجراءات:

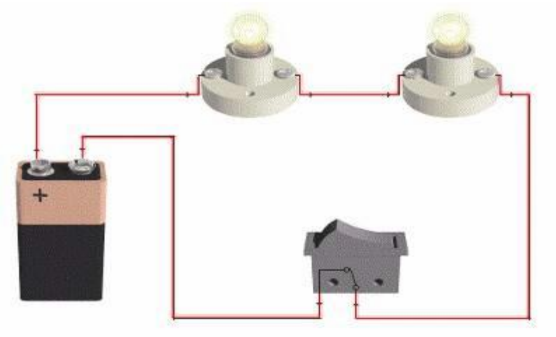
وصل الأسلاك بالبطارية والمصباح

هل أضاء المصباح؟ . . . .

إن ما قمت بتكوينه لإضاءة المصباح يسمى دائرة كهربائية لماذا في رأيك سميت بهذا الاسم ؟

....

أضف قاطع كهربائي (مفتاح) إلى الدائرة الكهربائية التي عملتها



افتح القاطع وأغلقه عدة مرات ماذا تشاهد :

....

ما هي فائدة القاطع الكهربائي الذي أضفته؟

....

كيف يعمل القاطع

....

قم بإضافة مصباح أخر كما في الشكل المقابل

اكتب تقريرا مختصرا عن التجربة التي عملتها

الهدف من التجربة:

الإجراءات التي قمت بها:

النتائج التي توصلت إليها:

وحدة الكهرباء

نشاط رقم 4

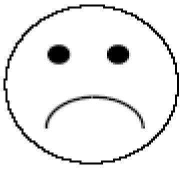
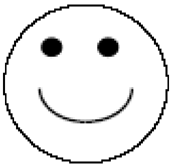
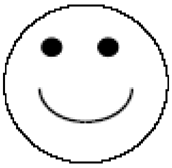
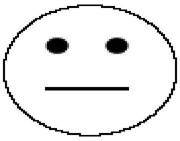
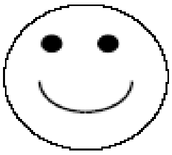
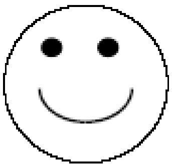
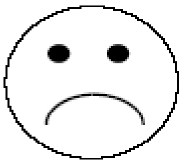
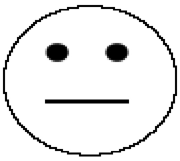
نشاط إضافي

حاول باستخدام الأدوات السابقة أن تعمل دائرة كهربائية بمصباحين ولكن بطريقة مختلفة عن التي عملتها في النشاط السابق

ارسم الدائرة التي عملتها

اشرح كيف عملتها:

التقويم الذاتي

عملت دائرة كهر بائية			
تعرفت على فوائد مفتاح الكهرباء			
عملت دائرة كهر بائية كما هو موضح في الرسمة			
كتب التقرير عن التجربة			
شعوري حول هذا النشاط			

إذا واصلت العمل في هذا النشاط سوف أحاول أن افهم

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أفضل شي تعلمته من هذا النشاط هو

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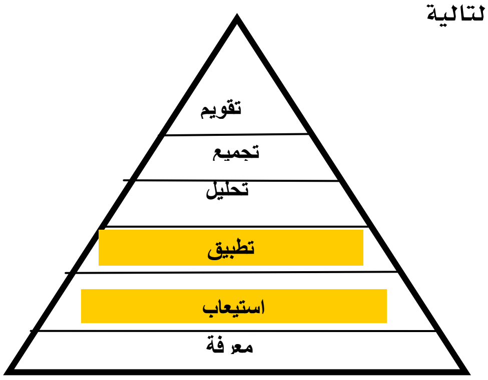
هل ترشح إدراج هذا النشاط في محفظة التقويم نعم ☐ لا ☐

بين لماذا ....

نشاط رقم 4

ورقة المعلم

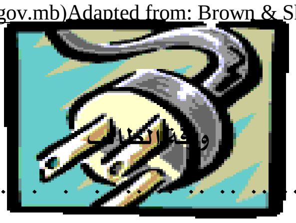
التعلم الفعال	أ - يركز هذا النشاط على تعليم المعارف والمهارات التالية 1- مهارات المعرفة والتفكير: • الملاحظة • كتابه فروض علمية • إجراء تجربه • استنتاج 2-المحتوى المعرفي للنشاط: • سوف يتمكن التلميذ من • تكوين دائرة كهربائية بسيطة • التعرف على وظيفة المفتاح في الدائرة الكهربائية. ب- يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية 
الوقت	20- 30 دقيقه
خلفية المعلم عن النشاط	الدائرة الكهربائية عبارة عن مسار مغلق تعبر من خلاله الكهرباء يجب أن يشتمل هذا المسار على مصدر للكهرباء كالبطارية مثلا وسلك موصل يسمح للالكترونات بالمرور بالإضافة إلى مصباح.
وصف النشاط	في هذا النشاط سوف يقوم الطلبة باستخدام أدوات بسيطة لتكوين دائرة كهربائية سوف يقوموا أولا بتكوين دائرة كهربائية بسيطة ثم يضيفوا عليها قاطع كهربائي للتعرف على وظيفة القاطع في فتح وإغلاق الدائرة ومن ثم إضاءة المصباح أيضا سوف يقوم التلاميذ بإضافة مصباح آخر للدائرة الكهربائية بالطريقة التسلسلية
عمل النشاط	في مجموعات
محددات الإجابة	يفترض أن تعطيك محددات الإجابات التي تقوم الطالب على أساسها وكذلك تقويم الطالب لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات الطلاب
إعطاء الطالب عمل إضافي	خلال قيامك بملاحظة التلاميذ أثناء قيامهم بالنشاط ومتابعة ا داؤه م يمكن أن تحصل على فكره مبدئية عن تقدمهم لذلك تقويم أداء التلاميذ على (محددات الإجابة) سوف تكون أيسر أي تلميذ يحصل على تقدير جيد أو اقل ينصح بإعطائه فرصه لتحسين عمله عن طريق طلب كتابه تقرير عن النشاط أو إعطائه واجب إضافي يساعده على فهم الموضوع أو بكلا الاجرائين أما الطالب الذي ينتهي من عمله مبكرا فبنصح بإعطائه نشاط إضافي

وحدة الكهرباء

نشاط رقم5

المواد الموصلة والعازلة للكهرباء

; www.NASAexplores.com, http://www.edu.gov.mb)Adapted from: Brown & Shavelson, Assessing Hands-On Science (1996



ورقة الطالب

. . . . الاسم. .. .. المدرسة. . . . .

معايير التقويم

معايير الأداء	ممتاز (4)	جيد جدا (3)	جيد(2)	يحتاج إلى تحسن (1)
اتبع التعليمات لتنفيذ التجربة				
سجل توقعاته و اختبر المواد عن طريق دائرة كهربائية ثم سجل ملاحظاته				
صنف المواد إلى موصلة وعازلة للكهرباء				
ذكر استخدامات المواد الموصلة والعازلة للكهرباء				
كون ورسم دائرة كهربائية بمصباحين				
الدرجة الكلية				

__________تواصل مع المعلم بشكل مناسب.

__________شارك في أداء النشاط مع زملائه

__________أكمل نموذج التقويم الذاتي

__________استخدم الأدوات بشكل مناسب

__________اظهر قدر من المسؤولية تجاه نفسه وتجاه الآخرين.

توزع النقاط على الشكل التالي:

4 نقاط إذا كان العمل صحيحا ، كاملا ،و مفصلا

3نقاط إذا كان العمل معظمه صحيح ، كاملا ،ومفصلا

2نقاط إذا كان العمل صحيح لحد ما ، غير مكتمل و ينقصه بعض التفاصيل

1نقاط غير صحيح أو لم يكمل ويحتاج إلى مساعدة

ملاحظات المعلم

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نشاط رقم 5

المواد الموصلة والعازلة للكهرباء

مشروع إنارة

انظر إلى البيت الذي في يسار الصفحة، يحتاج إلى إضاءة للباب الخارجي سوف تقوم بمفردك أو مع زملائك بتصميم نموذج مصغر لإنارة هذا الباب بمصباحين ومفتاح واحد.

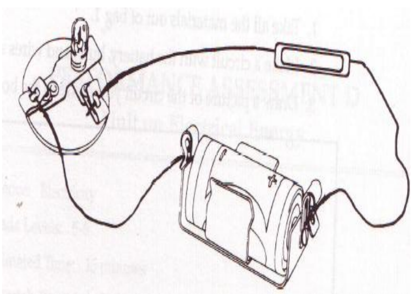
المطلوب منك في هذا المشروع

اختيار المواد المناسبة لتوصيل الكهرباء وكذلك المواد التي يمكن أن تستخدم لصناعة الافياش، وتغليف أسلاك الكهرباء.

عمل نموذج مصغر لإنارة مصباحين باستخدام الرسم المرفق

الأدوات: بطارية، سلك نحاسي، ساقا من الزجاج، قطعة من البلاستك، قطعة من الخشب، ، ساقا من الحديد، مصباحا، قاطع (مفتاح) ، زرادية.

الجزء الأول:



خمن أولا ثم بعد ذلك حدد بالتجربة أي من المواد التالية موصل أو عازل للكهرباء سلك نحاسي، ساقا من الزجاج، قطعة من البلاستك، قطعة من الخشب، ، ساقا من الحديد

المواد	التخمين (قبل إجراء التجربة)		المشاهد بالتجربة	
	عازل	موصل	عازل	موصل

هل كل توقعاتك كانت صحيحة ؟..............................

2- أعد تصنيف تلك المواد إلى موصلة وعازلة للكهرباء

كيف يمكنك الاستفادة من تلك المواد في مشروعك

....

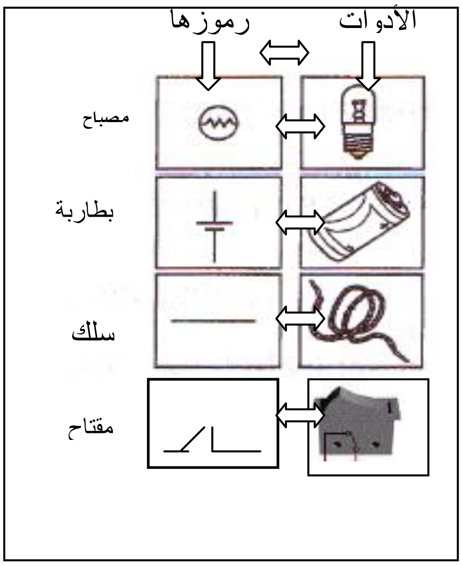
....

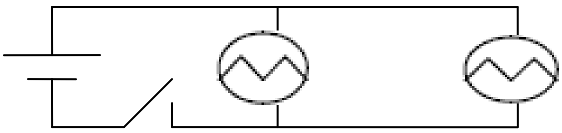
....

....

الجزء الثاني

قم بتنفيذ إنارة الباب الخارجي حسب الشكل رقم (1) مستعينا بجدول رموز الأدوات على يمين الشكل .





شكل رقم (1)

أرسم باستخدام أشكال الأدوات الإنارة التى نفذتها

التقويم الذاتي

ضع إشارة (√) تحت العبارة التى ترى أنها تعكس مستوى فهمك لهذا النشاط

	4	3		1
المواد الموصلة والعازلة	استطيع أن أميز الآن بكل سهولة بين المواد الموصلة والعازلة للكهرباء ☐	استطيع أن أتعرف على كل من المواد الموصلة و العازلة للكهرباء فقط من خلال التجربة ☐	لست متأكد مما إذا كنت استطيع التعرف على المواد الموصلة والعازلة للكهرباء ☐	ارغب في إعادة التجربة للتعرف على المواد الموصلة والعازلة للكهرباء ☐
استخدامات المواد الموصلة والعازلة للكهرباء	استطيع أن اذكر العديد من الاستخدامات للمواد الموصلة والعازلة للكهرباء ☐	استطيع أن احدد بعض استخدامات المواد الموصلة للكهرباء ولكن لا ادري فيما إذا تستخدم المواد غير الموصلة (أو العكس) ☐	لا استطيع أن احدد بالضبط كيف تستخدم المواد الموصلة وغير الموصلة للكهرباء ☐	لا اعرف أي استخدام لكل من المواد الموصلة والعازلة للكهرباء ☐
تكوين دائرة كهربائية باستخدام رسم توضيحي	استطيع من خلال رموز الرسم التوضيحية أن أكون دائرة كهربائية ☐	استطيع أن أكون دائرة كهربائية بالاستعانة برسم توضيحي ولكن لدي صعوبة في التعرف على رموزها ☐	استطيع أن أكون بعض أجزاء الدائرة الكهربائية بالاستعانة برسم توضيحي ☐	لا استطيع أن أكون دائرة كهربائية بالاستعانة برسم توضيحي ☐

إذا واصلت العمل في هذا النشاط سوف أحاول ان افهم

....

....

....

أفضل ما تعلمت من هذا النشاط هو

....

....

نشاط رقم 5

وحدة الكهرباء

نشاط إضافي

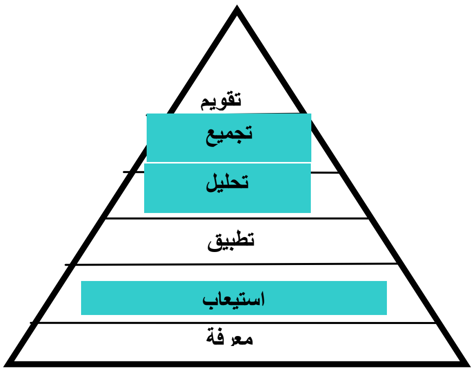
الاسم . . . . .المدرسة . . . .

من خلال عملك في النشاط السابق حاول أن تكتب تعريفا لكل من المواد الموصلة والعازلة للكهرباء

نشاط رقم 5

وحدة الكهرباء

ورقة المعلم

التعليم الفعال	أ - يركز هذا النشاط على تعليم المعارف والمهارات التالية 1- مهارات المعرفة والتفكير: • الملاحظة • كتابه فروض علمية • إجراء تجربه • استنتاج المحتوى المعرفي للنشاط: • يصف بعض المواد بناء على نتائج تجريبية إلى مواد موصلة وعازلة للكهرباء. • يكون دائرة كهربائية بالطريقة المتوازية ب- يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية • تنمية اهتمام التلميذ للقيام بتجارب علمية 
الوقت	20- 30 دقيقه
خلفية المعلم عن النشاط	الدائرة الكهربائية عبارة عن مسار مغلق تعبر من خلاله الكهرباء يجب أن يشتمل هذا المسار على مصدر للكهرباء كالبطارية مثلا وسلك موصل يسمح للالكترونات بالمرور بالإضافة إلى مصباح بعض المواد تسمح بمرور الالكترونات بسهولة بينما البعض لا يسمح مواد كالنحاس مثلا يعتبر من الموصلات الجيدة بينما بعض المواد كالبلاستك لا يسمح بمرور الكهرباء.
وصف النشاط	في هذا النشاط سوف يقوم التلميذ أولا بتخمين ما إذا كانت المواد المعروضة أمامه موصلة أو غير موصلة للكهرباء ويدون ذلك في الجدول المخصص ثم بعد ذلك يقوم بالاشتراك مع أفراد مجموعته باختبار تلك المواد في الجزء الثاني من النشاط سوف يقوم ببناء دائرة كهربائية بالطريقة المتوازية مستعينا بالرسم المعروض
عمل النشاط	في مجموعات
محددات الإجابة	يفترض أن تعطيك محددات الإجابات التي تقوم الطالب على أساسها وكذلك تقويم التلميذ لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات الطلاب
إعطاء الطالب عمل إضافي	خلال قيامك بملاحظة التلاميذ أثناء قيامهم بالنشاط ومتابعة ا داؤه م يمكن أن تحصل على فكره مبدئية عن تقدمهم لذلك تقويم أداء التلاميذ على (معايير التقويم) سوف تكون أيسر أي تلميذ يحصل على تقدير(جيد) أو اقل ينصح بإعطائه فرصه لتحسين عمله عن طريق طلب كتابة تقرير عن النشاط أو إعطائه واجب إضافي يساعده على فهم الموضوع أو بكلا الاجرائين أما التلميذ الذي ينتهي من عمله مبكرا فينصح بإعطائه نشاط إضافي

وحدة الكهرباء

نشاط رقم (6)

فوائد الكهرباء

مجموعة . . . .

أسماء التلاميذ:

1- ....

2- ....

3- ....

4- ....

5- ....

عمل المجموعة سوف يقوم بناء على هذه المعايير

المعايير	الدرجة	التقدير
ذكروا معظم الأجهزة الكهربائية صنفوا تلك الأجهزة إلى مجموعات مناسبة أعادوا بشكل صحيح تصنيف كل الأجهزة بناء على استهلاكها للكهرباء اقترحوا بعض الطرق المبتكرة والعملية لترشيد استخدام الكهرباء قدموا عملهم بشكل واضح للمجموعات الأخرى	4	ممتاز
ذكروا بعض الأجهزة الكهربائية صنفوا معظم تلك الأجهزة إلى مجموعات مناسبة أعادوا تصنيف معظم الأجهزة بناء على استهلاكها للكهرباء بشكل صحيح اقترحوا بعض الطرق المفيدة لترشيد استخدام الكهرباء قدموا عملهم بشكل واضح للمجموعات الأخرى مع وجود بعض الأخطاء	3	جيدا جدا
ذكروا عدد محدود من الأجهزة الكهربائية صنفوا عدد محدود من تلك الأجهزة إلى مجموعات مناسبة. اقترحوا بعض الطرق التي يصعب الاستفادة منها في ترشيد استخدام الكهرباء قدموا عملهم للمجموعات الأخرى بشكل غير واضح	2	جيد
لم يجيبوا على الأسئلة بشكل صحيح	1	يحتاجون إلى تحسين أداء

نشاط رقم (6)

فوائد الكهرباء

أصبحت الكهرباء عنصر أساسي في حياتنا، نستخدمها لأغراض مختلفة في المنزل ، في المدرسة وفي أماكن أخرى عديدة ومع عظيم فائدتها إلا إنها مكلفه كما إنها خطره جدا إن لم تستخدم بشكل سليم.

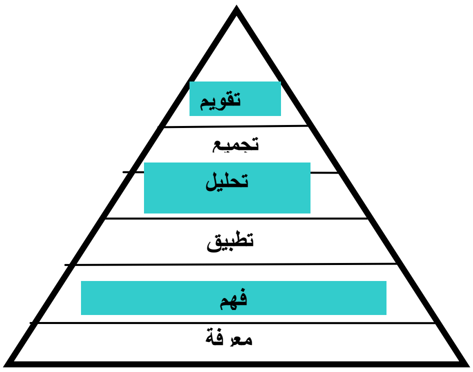
كمجموعة تناولوا النقاط التالية، ثم بعد ذلك قدموا النتائج التي توصلتم إليها للمجموعات الأخرى:

- عدد بالاشتراك مع زملائك ا كبر عدد ممكن من الأجهزة الكهربائية مع تصنيفها إلى مجموعات (أجهزة للإضاءة، للتبريد ، للتسخين ،.للطبخ .)
- تقديم بعض المقترحات لترشيد استهلاك الكهرباء في المنزل والمدرسة
- تحديد مخاطر الكهرباء مع وضع قواعد لتجنب تلك المخاطر.

نشاط رقم (6)

وحدة الكهرباء

ورقة المعلم

التعليم الفعال	- أ يركز هذا النشاط على تعليم المعارف والمهارات التالية 1- مهارات المعرفة والتفكير: • مهارات الاتصال • التحليل • التقويم  المحتوى المعرفي للنشاط: • يتعرف على فوائد الكهرباء • يستخدم المفردات المناسبة المرتبطة باستخدامات الكهرباء.
الوقت	30- 40 دقيقة
وصف النشاط	في هذا النشاط سوف يقوم التلاميذ بالتعرف على فوائد الكهرباء من خلال حصر بعض تطبيقاتها ثم تصنيف تلك التطبيقات إلى مجموعات بناء على استهلاك الكهرباء أيضا سوق يقوم التلاميذ في هذا النشاط باقتراح بعض الأساليب لترشيد استهلاك الكهرباء وعرض تلك المقترحات أمام المجموعات الأخرى
كيفية القيام بالنشاط	وزع التلاميذ إلى مجموعات اتبع طريقة التعليم التعاوني في عمل المجموعات اطلب من كل مجموعة أن تقدم عملها أمام المجموعات الأخرى

وحدة الكهرباء

اكتشف اللغز

Adapted from: Batteries, Chapter1, Students Achievement on The Performance Assessment Tasks, TIMSS,1995, http://timss.bc.edu/timss1995i/TIMSSPDF/PAchap1a.pdf

اسم الطالب__________________________ المدرسة ________________________

الأدوات كشاف، أربع بطاريات معلمه أ،ب،ج،س.

اقرأ التعليمات بعناية

مهمتك بالتحديد، هي: اكتشاف أي من البطاريات الأربع صالحة وأي منها منتهي الصلاحية.

هذا ما يجب أن تفعله:

فكر كيف يمكنك حل هذه المشكلة.

بعد ذلك اعمل لاكتشاف أي من البطاريات منتهية وأيها في حالة جيدة.

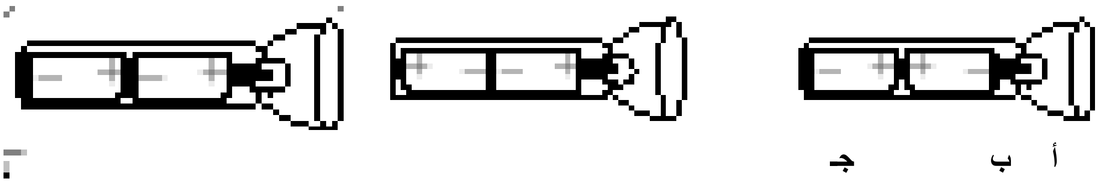
1- بناء على تفحصك للبطاريات، حدد البطاريات المنتهية والبطاريات الصالحة بكتابة الحروف التى مدونه على كل منها:

البطاريات الجيدة هي:____________________________

البطاريات المنهية هي ____________________________

2- اشرح كيف حددت البطاريات المنتهية

3- كيف يجب أن توضع البطاريتان ليضيء الكشاف؟ يوجد ثلاث طرق مختلفة لوضع البطاريتان داخل الكشاف ارسم دائرة حول الصورة التى تعتقد أنها توضح الطريقة الصحيحة



أ ب جـ

4- لماذا الطريقة التي اخترتها تمثل أفضل طريقة

مهمة البطارية

ورقة المعلم

في هذه المهمة سوف يزود الطلبة بأربع بطاريات متساوية الحجم وغير معروفة المعالم اثنان منها صالح وآخران منتهي الصلاحية (بمعنى لا يمكن أن يضيء المصباح باستخدامه) و يكتب على كل واحد منها احد الحروف الهجائية مع تسجيل أي منها صالح وأي منها منتهي في ورقة تصحيح المهمة أدناه و كشاف.

للبدء في أداء المهمة يطلب من التلاميذ اكتشاف أي من البطاريات صالحة وأي منها منتهية المهمة تهدف إلى قياس قدرة التلاميذ على تطوير وتنفيذ طريقة لحل المشكلة واستخدام أدلة تجريبية لدعم استنتاجاتهم، وكذلك اختبار معارف محددة حول الكهرباء لحل مشاكل روتينية أيضا تهدف المهمة إلى تطوير مفاهيم بالاعتماد على إيضاح الحلول .

الفقرة رقم 1 تتطلب من الطالب تحديد البطارية الجيدة الأمر الذي يمكن تحقيقه بعملية منظمة لمحاولات الصح والخطأ.

الفقرة رقم 2 تستلزم وصف الإستراتيجية المستخدمة لتحديد البطاريات الجيدة.

الفقرة رقم 3 تتطلب اختيار الترتيب الصحيح للبطاريتين داخل الكشاف.

الفقرة رقم 4 تستدعى الطلبة لشرح لماذا حلولهم صحيحة مما يتطلب معرفة مفهوم الدائرة الكاملة وفهم اتجاه مرور التيار الكهربائي.

تحديد البطاريات الصالحة والمنتهية:

الصالحة بطارية (أ) و (ج)

المنتهية (ب) و (د)

محددات الإجابة الصحيحة :

الفقرة:1 تحديد أي من البطاريات صالحة وأي منها منتهية (الدرجة الكاملة 2).

الفقرة:2 وصف كيفية تحديد البطاريات المنتهية:

وضح بالدليل اختبار دقيق ومنظم لتجميعات مختلفة من البطاريات.

المنظم يعد دليل لمحاولة كل التجميعات الممكنة للبطاريات أو محاولات اختيار تجميعات باستخدام التفكير والمعرفة العلمية لاستبعاد بعض المحاولات (الدرجة الكاملة 2).

الفقرة:3 تحديد الترتيب الصحيح للبطاريات داخل الكشاف، الإجابة الصحية (×) الدرجة (1)

الفقرة:4 شرح لماذا اختياره كان الأفضل :

حدد الاختيار الصحيح.

ضمن إجابته الدائرة الكهربائية المغلقة أو طريقة مرور التيار الكهربائي في اتجاه واحد(الدرجة القصوى2).

وحدة الكهرباء

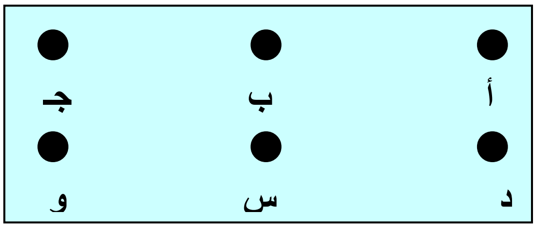
المهمة الثانية

Adapted from: Mystery Card 3, New York State Education Department (NYSED) NYS Alternative Assessment in Science Project (1996), http://pals.sri.com/pals/tasks/k-4/Mystery3/

في هذه المهمة سوف تستخدم مسبار كهربائي لتحديد المسارات التى تنتقل بها الكهرباء داخل الدوائر الكهربائية المخفية بين النقاط الموضحة في البطاقة

المواد

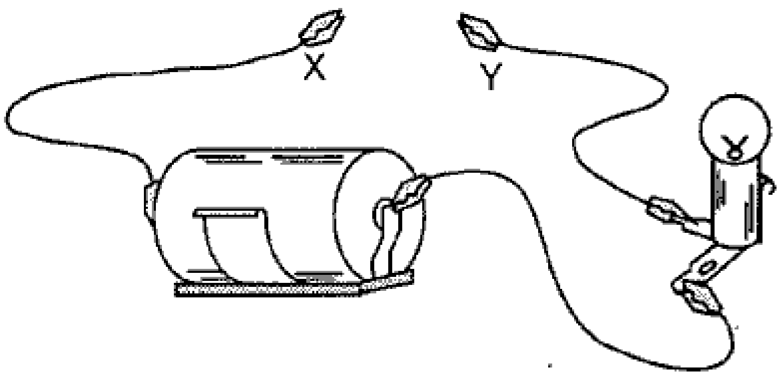
- مسبار كهربائي
- بطاقة



التعليمات

لامس طرفي المسبار للتأكد من أن المصباح يضيء .

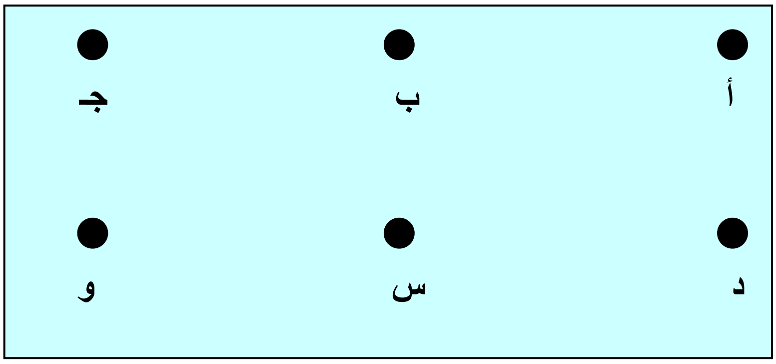
ضع احد طرفي المسبار على النقطة (أ) وفي نفس الوقت ضع الطرف الآخر على النقطة(ب) إذا المصباح أضاء ضع (✓) تحت نعم وان لم يضيء ضع (✓) تحت لا في الجدول في الصفحة الثانية .



قم بنفس الخطوات مع بقية النقاط وسجل ملاحظاتك مباشرة في الجدول

التوصل بين نقطتين	أضاء المصباح	
	نعم	لا
أ ← ب		
أ ← جـ		
أ ← د		
أ ← س		
أ ← و		
ب ← جـ		
ب ← د		
ب ← س		
ب ← و		
جـ ← د		
جـ ← و		
جـ ← س		
د ← س		
د ← و		
و ← س		

بناء على النتائج التى توصلت إليها وصل بخط بين النقاط التي توصل التيار الكهربائي



المهمة الثانية لوحدة الكهرباء

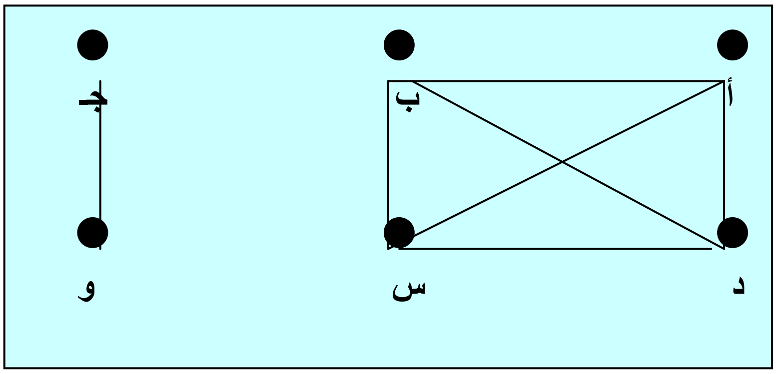
ورقة المعلم

في هذه المهمة سوف يقوم الطالب باختبار دوائر كهربائية مخفية بين نقاط محددة على بطاقة تضم ست نقاط عن طريق تحديد النقاط التى بينها توصيلات من خلال استخدام الكشاف الكهربائي حيث يضيء المصباح عند ملامسة طرفي الكشاف لنقطتين بينهما موصل كهربائي .

يمكن عمل التوصيل بين النقاط بأي طريقة تراها على أن تحدد النقاط التى بينها توصيل قبل تغليفها ببطاقة بلاستيكية أو رقية ومن ثم بشريط لاصق من المهم أن تجرب تلك التوصيلات قبل توزيعها على الطلبة وكذلك توحيد طريقة التوصيل بين كل البطاقات التى توزع على المجموعات

الإجابة الصحيحة:

التوصيل بين نقطتين	أضاء المصباح	
	نعم	لا
أ ← ب	✓	
أ ← جـ		✓
أ ← د	✓	
أ ← س	✓	
أ ← و		✓
ب ← جـ		✓
ب ← د	✓	
ب ← س	✓	
ب ← و		✓
جـ ← د		✓
جـ ← و	✓	
جـ ← س		✓
د ← س	✓	
د ← و	✓	
و ← س		✓



طريقة التصحيح:

يعطى الطالب درجة لكل إجابة صحيحة على الجدول ومن ثم تقسم الدرجة الكلية على 5 لتصبح الدرجة الكلية القصوى 3 درجات .،كما يعطى درجة إذا استخدم البيانات في رسم طريقة التوصيل بشكل صحيح بين النقاط على الأقل لنصف المعلومات التى جمعها في الجدول الدرجة الكلية القصوى 4 درجات .

واجب منزلي للأسبوع الأول

مادة العلوم

الاسم ______________________ المدرسة ______________________

تعليمات القيام بالواجبات:

يتضمن الواجب العديد من الأسئلة التى يفترض أن تحلها خلال أسبوع وتعيدها لمعلمك في بداية الأسبوع التالي.

لا تقم بحل كل الأسئلة مرة واحدة، ولكن بعد كل حصة علوم قم بحل الأسئلة المرتبطة بموضوع الحصة.

يهدف الواجب المنزلي إلى ترسيخ فهمك للموضوعات التى أخذتها في المدرسة أو فهم ما لم تتمكن من فهمه في وقت الحصة، لذا احرص دائما على أدائه وتسليمه في الوقت المناسب.

إذا لم تستطع أو لم تفهم أحد الأسئلة يمكنك أن تسأل المعلم أو أحد أفراد أسرتك لشرح ما أشكل عليك فهمه وبعد ذلك قم بحل السؤال بنفسك.

أداؤك للواجب سوف يصحح وفق الجدول التالي:

معايير التقويم

4	سلم الطالب الواجب في الوقت المحدد أجاب على كل الأسئلة إجابات صحيحة ودقيقة. أوراق الواجب نظيفة و مكتوب بخط واضح أعتمد على نفسه في عمل الواجب
3	سلم الطالب الواجب في الوقت المحدد أجاب على معظم الأسئلة إجابات صحيحة ودقيقة. أوراق الواجب نظيفة إلا أن الخط غير واضح أعتمد على نفسه في عمل الواجب
2	سلم الطالب الواجب بعد يوم من موعده أجاب على كل أو معظم الأسئلة إجابات صحيحة ودقيقة. أوراق الواجب ليست نظيفة تماما أعتمد على نفسه في عمل الواجب
1	تأخر الطالب في تسليم الواجب. أجاب على بعض الأسئلة إجابات صحيحة أوراق الواجب ليست نظيفة لم يعتمد على نفسه كليا في عمل الواجب
صفر	سوف يعطى وقتا إضافيا لإكمال أو إعادة عمل الواجب

ملاحظات المعلم

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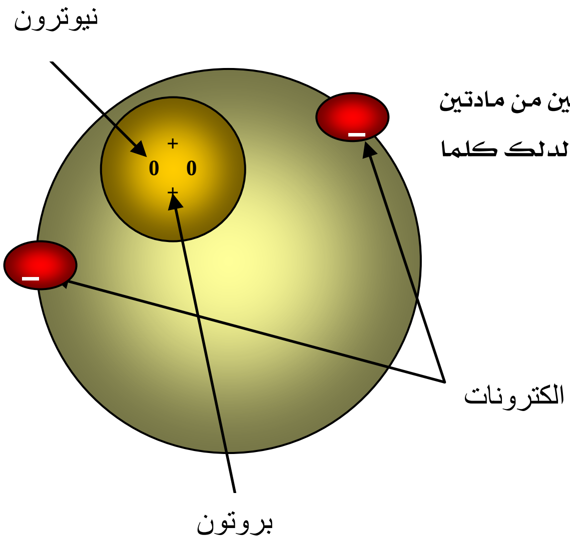
أضف إلى معلوماتك:

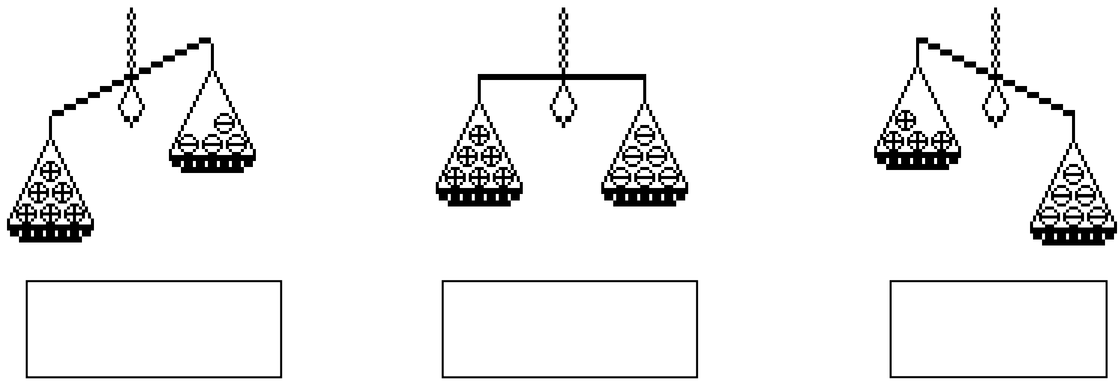
كل المواد تتكون من أجزاء صغيره جدا لا ترى بالعين تسمى الذرات في وسط الذرة توجد النواة وهي تتكون من البروتونات التي تحمل شحنات موجبة (+) والنيترونات التي لا تحمل أي شحنة (0) النواة يحيط بها الكترونات ذات شحنات سالبة (-) كل ذرة تتكون من عدد متساوي من البروتونات والالكترونات لذلك فهي متعادلة أي أن الشحنات الموجبة متساوية مع الشحنات السالبة ولكن الالكترونات يمكن أن تنتقل من الذرة إلى ذرة في جسم آخر عندما ينتقل الإلكترون من الذرة يصبح عدد الشحنات الموجبة أكثر من عدد الشحنات السالبة بينما الذرة التي تنتقل إليها الالكترونات يصبح عدد الشحنات السالبة فيها أكثر.

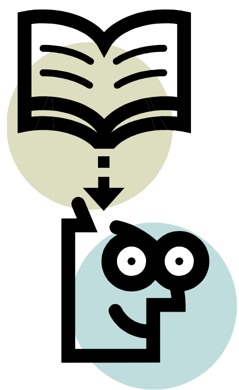
ولكن كيف يمكن أن ينتقل الإلكترون ؟

من أكثر الطرق وأسهلها لانتقال الالكترونات، أن تدلك جسمين مصنوعين من مادتين مختلفين كالبلاستك والصوف على سبيل المثال كلما زدت عدد مرات الدلك كلما انتقل المزيد من الالكترونات من احد الجسمين إلى الآخر



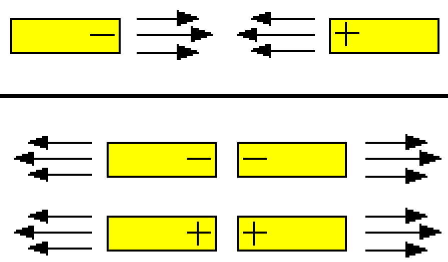
اكتب نوع الشحنة الأكثر تحت كل شكل من الأشكال التالية





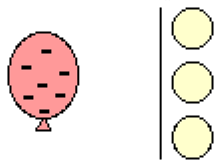
من الحقائق المعروفة في العلوم أن المواد المشحونة بشحنات مختلفة (شحنات موجبة وشحنات سالبة) تتجاذب وأظنك تأكدت من ذلك بالتجربة أما إذا كانت مشحونة بشحنات متشابهه كأن يكون كل منها مثلا مشحون بشحنة موجبة أو شحنة سالبة فإنها تتنافر كما هو موضح في الرسم التوضيحي التالي:

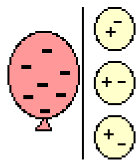
الشحنات المختلفة تتجاذب



الشحنات المتشابهة تتنافر

الجسم المشحون من الممكن أيضا أن يجذب الجسم المتعادل (أي الذي يحتوي على شحنات متساوية موجبة وسالبة) فكر مثلا كيف يمكن أن تجعل البالون يلتصق بالجدار، ببساطة إذا دلكت البالون بقطعة قماش وقربتها من الجدار سوف يكتسب البالون شحنات سالبة (-) وبالتالي يجذب الشحنات الموجبة في الجدار كما في الرسم التوضيحي التالي





أمثلة كثيرة يمكن ذكرها مما نتعرض له أحيانا وبعضها يكون بسيط غير مؤذي كالتصاق الثوب بالجسم أو وقوف شعر الرأس عند نزع القبعة خاصة إذا كانت مصنوعة من الصوف وبعضها أحيانا خطير جدا قد يؤدى إلى الوفاة مثل الصواعق ولذلك يقول الله سبحانه وتعالى " يجعلون أصابعهم في آذانهم من الصواعق حذر الموت والله محيط بالكافرين (البقرة، الاية19).

إذا كل الأمثلة التي ذكرناها تشير إلى ما يسمى (بالكهرباء الساكنة).

بعد قراءة القطعة السابقة، اجب عن الأسئلة التالية :

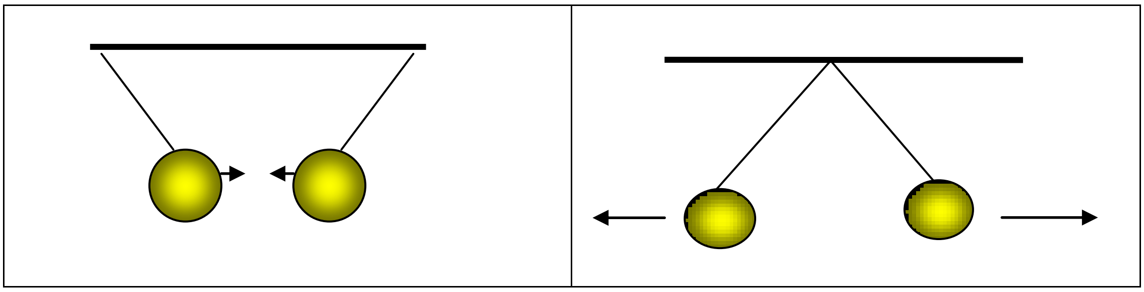
1- أكمل :

.الجسمان اللذان يحملان شحنات متشابهة . . . .

.الجسمان اللذان يحملان شحنات مختلفة . . . .

2- اذكر مثالا آخر عن الكهرباء الساكنة:

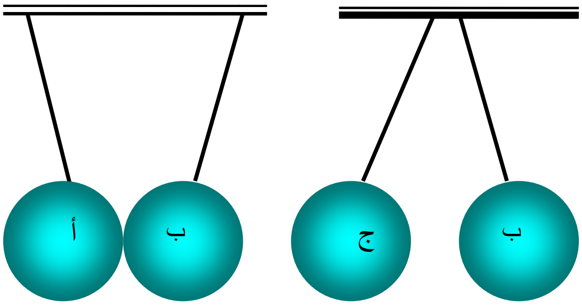
3- اكتب نوع الشحنة في كل من الحالات التالية



4- في مناسبين مختلفتين، ثم شحن ثلاثة بالونات أ، وب ، و جـ   البالون ب شحن في كل الحالات بشحنات سالبة بناء على ذلك وضح نوع الشحنة للبالونين أو ح في كل حالة :

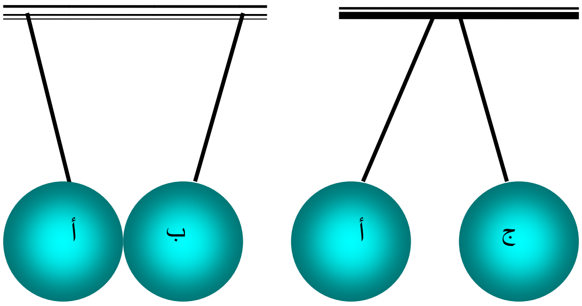
الحالة الأولى

البالون	نوع الشحنة
أ	
ب	(سالب)
ج	



الحالة الثانية

البالون	نوع الشحنة
أ	
ب	(سالب)
ج	



5- افترض التالي عند دخولك الفصل وجدت بالونين متدليان من السقف وبدلا من أن يكونا متدليان بشكل رأسي، يبدوان وكأنهما متنافران   كيف يمكن أن تفسر هذه الملاحظة؟

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6- أحد التلاميذ قام بتجربة شحن فيها عدة جسام وسجل الملاحظات التالية :

الجسم جـ	الجسم د	الجسم س	الجسم ص
جذب أ	جذب س تنافر مع جـ	تنافر مع ص	تجاذب مع ب

التلميذ يعرف أن الجسم (أ) شحن بشحنه سالبه والجسم (ب) متعادل   بما ذا شحنت الأجسام جـ ، ص، د، و س   فسر إجابتك؟

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واجب منزلي للأسبوع الثاني

مادة العلوم

الاسم ______________________ المدرسة ______________________

تعليمات القيام بالواجبات:

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- لا تقم بحل كل الأسئلة مرة واحدة، ولكن بعد كل حصة علوم قم بحل الأسئلة المرتبطة بموضوع الحصة.
- يهدف الواجب المنزلي إلى ترسيخ فهمك للموضوعات التى أخذتها في المدرسة أو فهم ما لم تتمكن من فهمه في وقت الحصة، لذا احرص دائما على أدائه وتسليمه في الوقت المناسب.
- إذا لم تستطع أو لم تفهم أحد الأسئلة يمكنك أن تسأل المعلم أو أحد أفراد أسرتك لشرح ما أشكل عليك فهمه وبعد ذلك قم بحل السؤال بنفسك.

أداؤك للواجب سوف يصحح وفق الجدول التالي:

معايير التقويم

4	سلم الطالب الواجب في الوقت المحدد أجاب على كل الأسئلة إجابات صحيحة ودقيقة. أوراق الواجب نظيفة و مكتوب بخط واضح أعتمد على نفسه في عمل الواجب
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صفر	سوف يعطى وقتا إضافيا لإكمال أو إعادة عمل الواجب

ملاحظات المعلم

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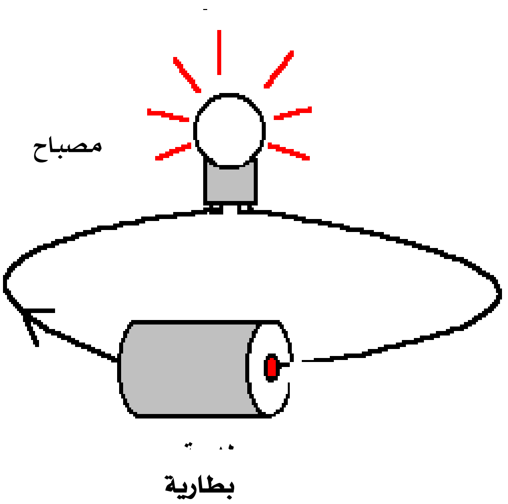
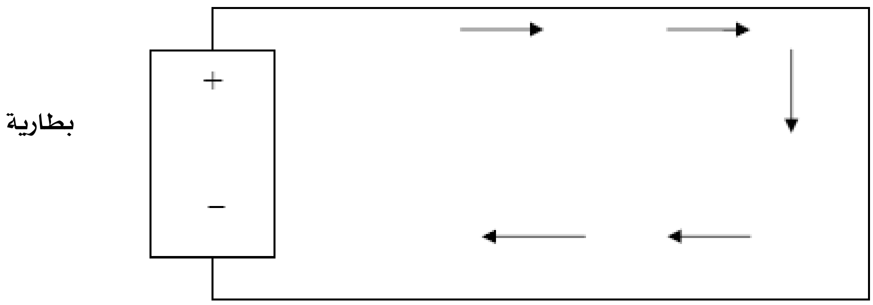
الدائرة الكهربائية



شكل رقم (1)

ماذا تعرف عن الدائرة الكهربائية؟

كثير من الأشياء التي نستخدمها في حياتنا سواء للإضاءة المنزلية أو لإضاءة مصابيح السيارات وكذلك إضاءة الأجهزة المختلفة كالتلفزيون أو الراديو أو الساعة الرقمية وغيرها الكثير تشترك في خاصية واحدة وهي استخدام الكهرباء لكي تعمل الكهرباء يجب أن تسير ضمن دائرة تسمى (الدائرة الكهربائية) يمكنك تصور الدائرة الكهربائية كمسار(طريق) تمر به الكهرباء، يمكن أن يكون بسيط كما في الكشاف أو معقد كما في بعض الأجهزة كالكمبيوتر والتلفزيون إلا أن الفكرة الأساسية تبقى واحدة وهي وجود مسار لمرور التيار الكهربائي.



لكي تعمل الدائرة الكهربائية بشكل صحيح يجب وجود ثلاث عناصر أساسية وهى المصباح، السلك الموصل ومصدر للكهرباء كالبطارية ، تكون متصلة مع بعضها بحيث تنتقل الكهرباء من الطرف الموجب(+) إلى الطرف السالب (-) على شكل دائرة مغلقة كما تشاهد في الشكل رقم (2).

فتح الدائرة الكهربائية يؤدي إلى انقطاع التيار الكهربائي لعدم قدرته على الانتقال من الطرف السالب إلى الموجب، لذلك للتحكم في إضاءة أو إطفاء المصباح نحتاج فقط إلى إغلاق الدائرة الكهربائية أو قطعها (فتحها) باستخدام القاطع (المفتاح)

1- بعد قراءة القطعة السابقة أجب عن الأسئلة التالية:

أ - كيف يعمل التيار الكهربائي؟

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ب- التيار الكهربائي ينتقل من الطرف . . . . . إلى الطرف . . . . .

جـ القاطع أو المفتاح الكهربائي يستخدم لإضاءة أو إطفاء النور أو المصباح اشرح كيف يحدث ذلك.

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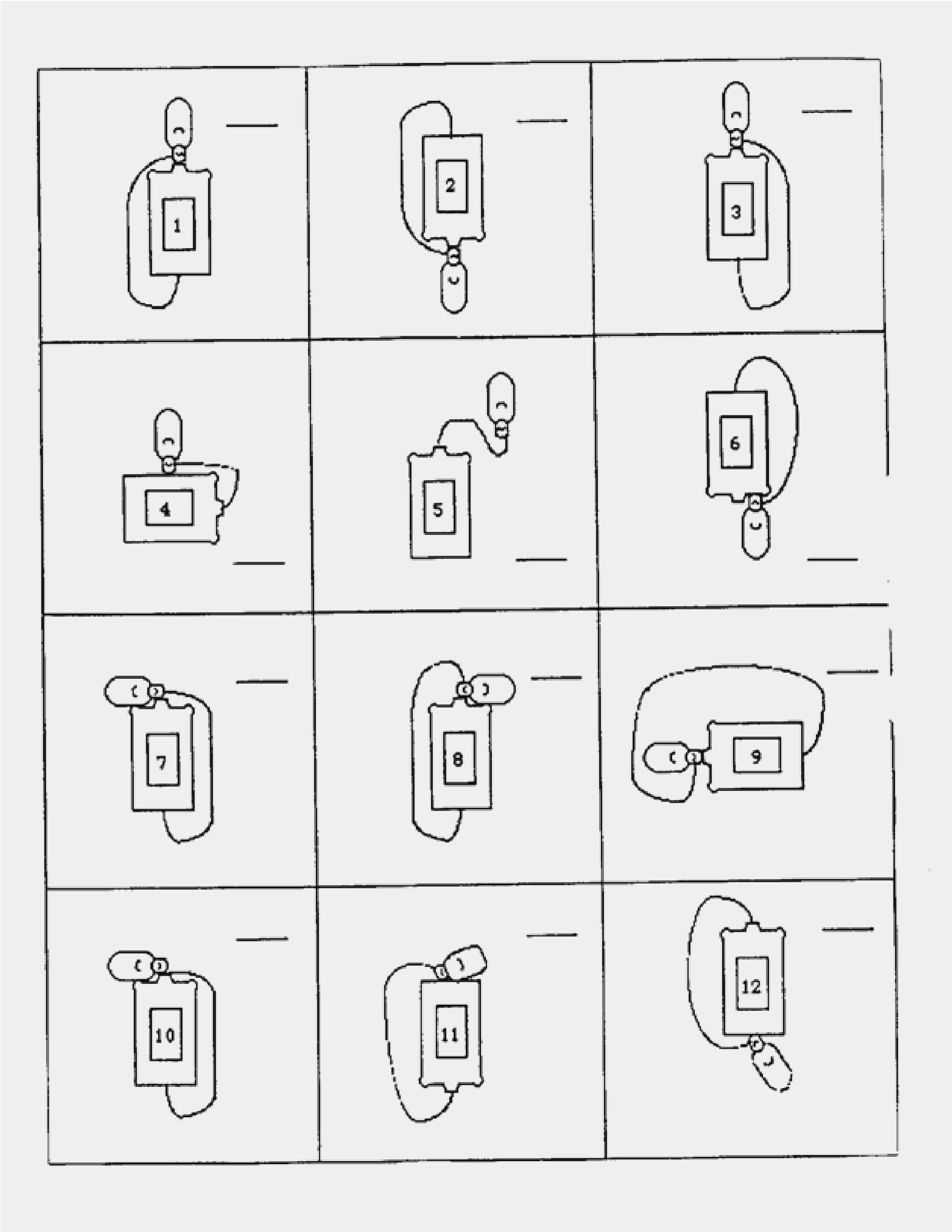
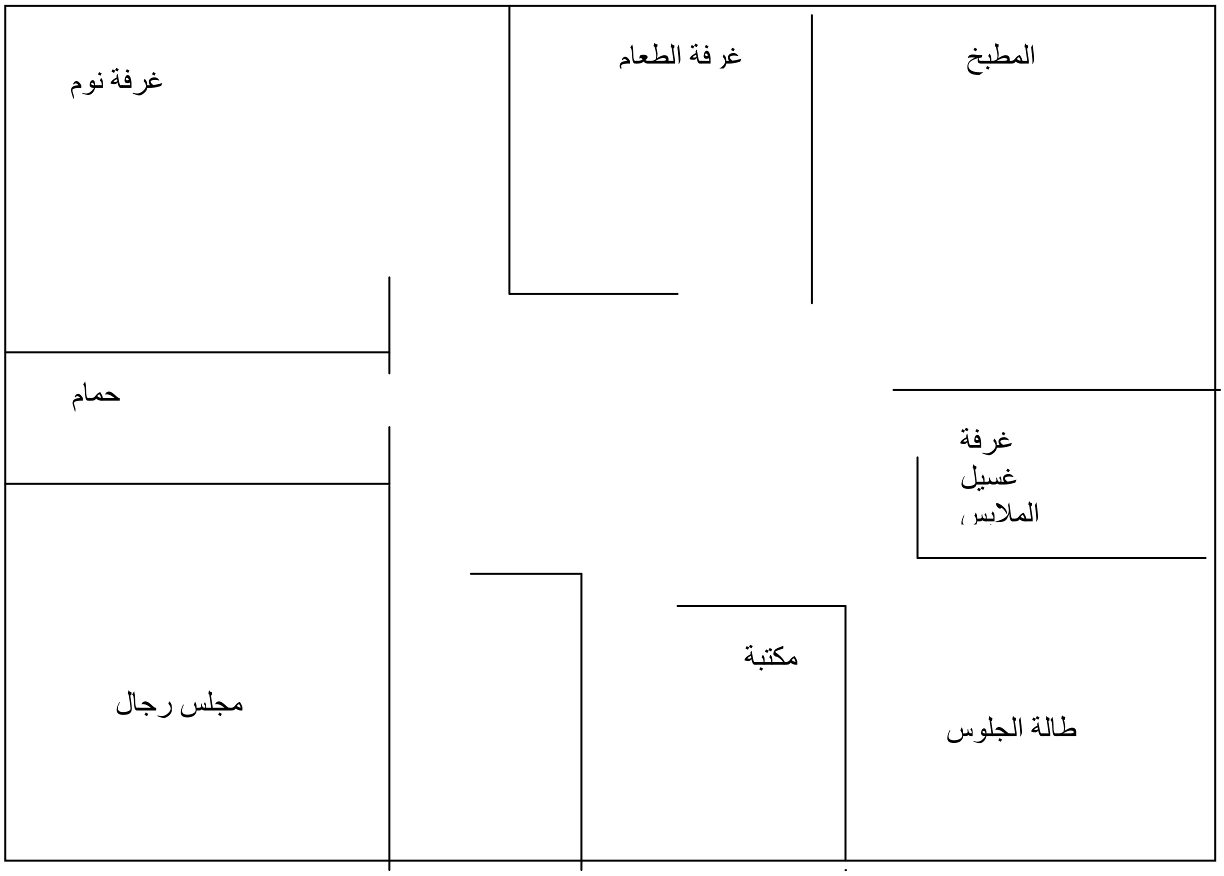
2 في الشكل أدناه عدة أشكال حول الدائرة الكهربائية ، ضع إشارة (/) بجوار كل شكل سوف يؤدى إلى إضاءة اللمبة و إشارة (X) بجوار الشكل الذي لا يؤدى الى إضاءتها



3 - المخطط التالي يوضح بعض الغرف الرئيسية في أحد المنازل ،اكتب قائمة بالأدوات والأجهزة الكهربائية التي تستخدم عادة في كل غرفة



قواعد السلامة

الكهرباء من النعم التي انعم الله بها علينا إذ أصبحت الحياة أيسر وأسهل وأكثر رفاهية، ولكن مع كل تلك الفوائد، الكهرباء لها مخاطر جسيمة إن لم نتعامل معها بشكل سليم فيما يلي بعض إرشادات السلامة اقرأها ثم أضف عليها بعض الإرشادات المهمة الأخرى :

عدم الإهمال بترك أسلاك الكهرباء عارية أو افياش مكسورة .

الحذر من رش الماء على افياش ومفاتيح و أسلاك الكهرباء.

عدم لمس افياش ومفاتيح الكهرباء عندما تكون أيدينا مبلله بالماء

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معايير تقويم العرض الشفهي

الاسم. . . . .

الصف .. .. المدرسة .. ..

الوحدة.. .. .. التاريخ .. .. الدرجة . . . .

	4 انجاز تام	3 انجاز كبير	2 انجاز جزئي	1 انجاز قليل لا يوجد انجاز
العرض	يتكلم بوضوح وبصوت عالي يحافظ على تواصل بصري مع الحضور استثار تفكير الحضور ورغبتهم في المشاركة. استخدم بعض أساليب التوضيح كالرسومات وغيرها بشكل ناجح	يتكلم بوضوح وبصوت مسموع لمعظم الحضور يحاول أن يحافظ على تواصل بصري مع المستمعين جذب انتباه الحضور للمتابعة استخدم بعض أساليب التوضيح كالرسومات وغيرها بشكل مناسب	يتكلم بصوت مسموع لنصف الحضور يبقي على تواصل بصري مع الحضور من حين لآخر حافظ على متابعة الحضور لفترة محدودة استخدم بشكل محدود بعض أساليب التوضيح كالرسومات وغيرها	يتكلم بصوت يسمعه عدد قليل من الحضور تواصله البصري مع الحضور قليل جدا لم يجذب الحضور للمتابعة لم يستخدم وسائل توضيح
المحتوى	في المحتوى العديد من الأفكار ألابتكاريه. المعلومات والتفاصيل الجزئية المرتبطة بالموضوع كثيرة يتضمن جميع المعلومات المطلوبة اشتمل على العناصر الأساسية للعرض (المقدمة والمتن والخاتمة)التى قدمت بشكل فعال	في المحتوى بعض الأفكار ألابتكاريه. قدم بعض المعلومات الأساسية والتفصيلية المرتبطة بموضوع مشروعه يتضمن معظم المعلومات المطلوبة اشتمل على العناصر الأساسية للعرض (المقدمة والمتن والخاتمة) التى قدمت بشكل مناسب	في المحتوى القليل من الأفكار ألابتكاريه. قدم القليل من المعلومات الأساسية والتفصيلية المرتبطة بموضوع مشروعه يتضمن بعض المعلومات المطلوبة اشتمل على العناصر الأساسية للعرض (المقدمة والمتن والخاتمة) التى قدمت بشكل مقبول.	في المحتوى فكرة ابتكاريه واحدة قليل جدا أو لا يوجد معلومات ترتبط بموضوع مشروعه يتضمن القليل من المعلومات المطلوبة. لم يشتمل على العناصر الأساسية للعرض (المقدمة والمتن والخاتمة)

S C.H.O.O.L.S. Science Kit/Assessment 4/01

تعليقات:

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مادة العلوم

وحدة الكهرباء

المشاريع

أختر واحدا فقط من المشاريع التالية:

عمر البطارية:

في هذا المشروع سوف تجرب ثلاثة أنواع من البطاريات للتعرف على أي واحده تدوم أطول.

المطلوب جمع ثلاث كشافات أو كشاف وثلاث بطاريات جديدة ذات حجم واحد و من ماركات مختلفة.

2- استهلاك الكهرباء:

في هذا المشروع سوف تقوم بمحاولة معرفة في أي من الفصول الأربعة يزداد استهلاك الكهرباء وفي أيها يقل الاستهلاك مع ذكر الأسباب في ذلك و اقتراح بعض الأساليب لخفض استهلاك الكهرباء

المطلوب جمع فواتير كهرباء من منزلكم لكل فصل من الفصول الأربعة .

نشرة دعائية (بروشور):

في هذا المشروع سوف تقوم بعمل تاجر أدوات كهربائية يريد أن يعمل دعاية تجارية لتعريف الناس بمميزات ما لدي من أجهزه كهر بائي.

المطلوب جمع بعض الصور أو الملصقات لبعض الأجهزة الكهربائية.

بناء مولد كهربائي

في هذا المشروع سوف تقوم ببناء مولد كهربائي مستخدما الأدوات التالية:

بوصلة

قطعة ماسورة من الكرتون

قطعة كرتون

سلكين من النحاس بمقابض

قضيب مغناطيس قوي

شريط لاصق

عند اختيارك لهذا المشروع سوف يزودك المعلم ببعض الرسوم التوضيحية التى تساعدك على تكوين المولد الكهربائي

تصميم وتنفيذ دوائر كهربائية

استخدم فكرة الدوائر الكهربائية في تنفيذ أي عمل تراه مناسبا بحيث يعمل على الكهرباء.

تعليمات عامة:

قبل القيام بأي عمل في المشروع الذي اخترته يجب وضع خطة تبين فيها الخطوات التى سوف تقوم بها ومناقشتها مع معلمك.

سوف تقوم بالعمل على المشروع الذي اخترته على عدة مراحل وسوف يتابع معلمك بمشيئة الله عملك في كل مرحلة.

يجب أن يكون العمل من إعدادك ولن يقبل أي عمل قام به غيرك.

يمكنك طلب المساعدة من والديك أو من الآخرين ولكن يجب أن تذكر أسماء كل من قام بمساعدتك أو المصادر التي استفدت منها

عملك سوف يقوم بناء على المعايير التالية:

معايير التقويم

المعايير	ممتاز (4)	جيد جيدا (3)	جيد (2)	يحتاج إلى مساعدة
خطة العمل	خطة العمل واضحة تماما ومرتبه في نقاط وقابله للتطبيق وتتسم بالمرونة	خطة العمل واضحة وقابله للتطبيق ومرتبة لحد ما وتتسم بالمرونة	خطة العمل واضحة لحد ما إلا أنها غير مرتبه في نقاط ومن الصعب تطبيقها	خطة العمل غير واضحة ولا يمكن تطبيقها
تنفيذ المشروع	نفذ كافة مراحل المشروع تحت إشراف المعلم ، نفذ توجيهات المعلم بتعديل أو تطوير العمل، أعتمد على نفسه كليا في عمل المشروع	نفذ معظم مراحل المشروع تحت إشراف المعلم ، نفذ معظم توجيهات المعلم بتعديل أو تطوير العمل، أعتمد على نفسه لدرجة كبيرة في عمل المشروع	نفذ بعض مراحل المشروع تحت إشراف المعلم ، نفذ بعض توجيهات المعلم بتعديل أو تطوير العمل، لم يعتمد على نفسه بالشكل المطلوب لإكمال المشروع	لم ينفذ المشروع تحت إشراف المعلم قدم عمل تم تنفيذه عن طريق شخص آخر
جودة العمل	يتسم العمل على الأقل بثلاثة من الخصائص التالية الابتكارية ، الإبداع ، تطبيقه لمفاهيم مرتبطة بموضوعات مادة العلوم، استخدام رسوم بيانية أو أشكال توضيحية أظهر العمل دليلا حقيقيا على القدرة على حسن التخطيط وبراعة التنفيذ	يتسم العمل على الأقل بخاصيتين من الخصائص التالية الابتكارية ، الإبداع ، تطبيقه لمفاهيم مرتبطة بموضوعات مادة العلوم، استخدام رسوم بيانية أو أشكال توضيحية أظهر العمل دليلا حقيقيا على القدرة على حسن التخطيط وبراعة التنفيذ	يتسم العمل على الأقل بخاصية واحدة من الخصائص التالية الابتكارية ، الإبداع ، تطبيقه لمفاهيم مرتبطة بموضوعات مادة العلوم، استخدام رسوم بيانية أو أشكال توضيحية أظهر العمل دليلا حقيقيا على القدرة على حسن التخطيط وبراعة التنفيذ	العمل غير جيد أو لا ترتبط جودته بعمل الطالب
الالتزام بمواعيد التنفيذ	التزم طوال فترات التخطيط والتنفيذ بالمواعيد المحددة لكل مرحلة	التزم معظم فترات التخطيط والتنفيذ بالمواعيد المحددة لكل مرحلة	التزم في بعض فترات التخطيط والتنفيذ بالمواعيد المحددة لكل مرحلة	تأخر في تقديم العمل

الوحدة العاشرة المغناطيس

ن	أهداف تدريس الفصل
1	أن يحدد الطالب المواد التي يجذبها المغناطيس.
2	أن يميز الطالب بين القطب الشمالي والقطب الجنوبي للمغناطيس
3	يستنتج أن الأقطاب المتشابهة تتنافر والمختلفة تتجاذب
4	أن يحدد الطالب استخدامات البوصلة
5	أن يوضح الطالب الأثر الناتج من إمرار التيار الكهربائي على قطعة من الحديد ملفوفة بسلك.
6	أن يعرف الطالب المجال المغناطيسي
7	أن يحدد الطالب المكان الذي ترتكز فيه قوة المجال المغناطيسي
8	أن يصف الطالب شكل المجال المغناطيسي

نشاط رقم (1)

المغناطيس

Adapted from: Barre Town Middle and Elementary School (2004), www.vermontinstitutes.org/assessment/pass_es/magnets/student.pdf; Magnets,www.michigan.gov. (2002). Lesson 1 - What's Attractive to Magnets?,http://www.michigan.gov/scope/0,1607,7-155-13481_13482_13485-37808--,00.html

ورقة الطالب

الاسم .... **المدرسة** ....

معايير التقويم

ممتاز(4)	جيد جدا(3)	جيد (2)	يحتاج إلى تحسن (1)
أجاب بشكل صحيح على كل الأسئلة سجل توقعاته ومشاهداته للمواد مع المغنطيس بشكل كامل صنف بشكل صحيح كل المواد إلى مجموعتين بناء على قابلتيها للمغنطة استنتج أهم خاصية تجعل الأجسام تنجذب للمغناطيس.	.أجاب على معظم الأسئلة بشكل صحيح.سجل توقعاته ومشاهداته لمعظم المواد مع المغنطيس صنف معظم المواد بشكل صحيح إلى مجموعتين بناء على قابليتها للمغنطة استنتج لماذا تنجذب المواد إلى المغناطيس.	أجاب على بعض الأسئلة بشكل صحيح.سجل توقعاته ومشاهداته لبعض المواد مع المغنطيس صنف بعض المواد بشكل صحيح إلى مجموعتين بناء على قابليتها للمغنطة حاول استنتاج لماذا تنجذب المواد إلى المغناطيس. .	معظم عمله غير صحيح ولا يرتبط بموضوع النشاط. إجابات فارغة

___________تواصل مع المعلم بشكل مناسب.

___________شارك في أداء النشاط مع زملائه

___________تبادل المعلومات مع زملائه

___________اتبع كل التعليمات.

___________استخدم الأدوات بشكل مناسب

___________اظهر قدر من المسؤولية تجاه نفسه وتجاه الآخرين.

ملاحظات المعلم

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وحدة المغناطيس

نشاط رقم (1)

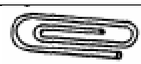
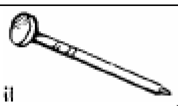
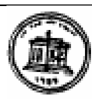
شركة لألعاب الأطفال ترغب في صنع لعبة جديدة باستخدام المغناطيس الشركة تحتاج إلى مساعدتك لإيجاد أفضل المواد التي تنجذب للمغناطيس لاستخدامها في صناعة هذه اللعبة.
المطلوب منك إذا أن تحدد بالتجربة العملية أي من المواد التي تمتلكها الشركة تنجذب للمغناطيس

المواد مغناطيس، عدد من المواد موضحة بالجدول

الإجراءات :

- 1 أمام كل مادة في الجدول أكتب توقعك هل تنجذب للمغناطيس أم لا ؟ ضع إشارة تحت (نعم) إذا كانت تنجذب للمغناطيس أو (لا) إذا كانت لا تنجذب بعد أن تنتهي قم بالخطوة الثانية.

2- قرب المغناطيس من كل مادة لنحدد ماذا كانت تنجذب للمغناطيس أم لا وسجل ملاحظاتك بالجدول تحت خانة (التجربة)

المو اد	التوقع		التجربة	
	نعم	لا	نعم	لا
 مغاط				
 مساكة ورق				
 كرة صغيرة				
 مسمار				
 طباشير				
 حبل				
 دبابيس بلاستك				
 عمله معدنية				
 مساحة				

هل كل توقعاتك صحيحة؟

2- اعد تصنيف المواد السابقة إلى مجموعتين المجموعة الأولى تنجذب للمغناطيس والمجموعة الثانية لا تنجذب

3- ما الخاصية المشتركة بين كل المواد التي تنجذب للمغناطيس

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4- بناء على النتائج التي توصلت البها من التجربة، أي المواد تنصح الشركة باستخدامها في صناعة اللعبة الجيدة ؟

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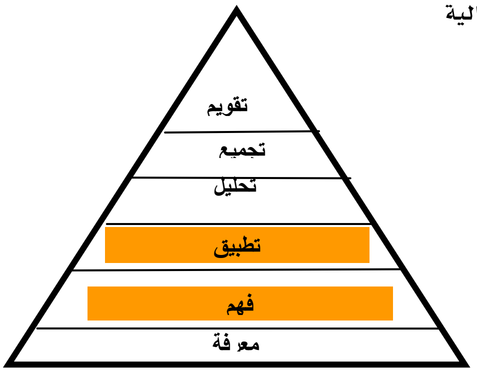
التقويم الذاتي

سجلت توقعاتي ومشاهداتي للمواد التي انجذبت أو لم تنجذب للمغناطيس.	1 2 3 4	لم استطع تسجيل توقعاتي ومشاهداتي للمواد التي انجذبت أو لم تنجذب للمغناطيس.
قمت بتصنيف المواد إلى مجموعتين (مجموعة تنجذب ومجموعة لا تنجذب للمغناطيس)	1 2 3 4	لم أقم بتصنيف المواد إلى مجموعتين (مجموعة تنجذب ومجموعة لا تنجذب للمغناطيس)
اعرف الآن ماهي المواد التى تنجذب الى المغناطيس	1 2 3 4	لا اعرف ماهي المواد التى تنجذب الى المغناطيس
راضي عن عملي مع المجموعة	1 2 3 4	لست راضي عن عملي مع المجموعة
هذا النشاط بسيط	1 2 3 4	هذا النشاط صعب

النشاط رقم(1)

المغناطيس

ورقة المعلم

<table>
<tr><td>التعليم الفعال</td><td>أ- يركز هذا النشاط على تعليم التلميذ المعارف والمهارات التطبيقية التالية
1- مهارات المعرفة والتفكير:
• الملاحظة
• التوقع
• إجراء تجربه
• استنتاج
2-المحتوى المعرفي للنشاط:
• أن يلاحظ التلميذ بالتجربة كيف يتعامل المغناطيس مع بعض الأجسام المختلفة .
• يصنف الأجسام بناء على ملاحظاته إلى مواد تنجذب ومواد لا تنجذب للمغناطيس.
• أن يستنتج أن المواد القابلة للمغنطة (التي تنجذب للمغناطيس) تصنع أو يدخل في صناعتها الحديد.
ب- يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية :
• أن ينمي التلاميذ حب الاستطلاع والاستكشاف لخصائص المغناطيس.
• أن يبحث عن دليل علمي لطرح استنتاجاته

</td></tr>
<tr><td>وصف النشاط</td><td>في هذا النشاط سوف يقوم التلاميذ أولا بعملية توقع أو تخمين لعدد من المواد فيما إذا كانت تنجذب أولا للمغناطيس، بعد أن يكملوا ذلك في الجدول سوف يقومون بتجريب مغناطيسية تلك المواد ثم يسجلون ملاحظاتهم في الخانة الثانية من الجدول أيضا سوف يقوم التلاميذ بإعادة تصنيف المواد إلى مجموعتين مجموعة تنجذب إلى المغاطيس ومجموعة لا تنجذب بهدف التعرف على الخاصية المشتركة بين المواد القابلة للمغنطة في السؤالين الأخيرين ينبغي أن يتوصل التلاميذ الى أن المغناطيس يجذب المواد المصنوعة من الحديد أو التي يدخل في صناعتها الحديد أن لم يصل التلاميذ الى تكوين هذا المفهوم فينبغي مناقشتهم في ذلك وطرح بعض الأسئلة حول طبيعة كل جسم من الأجسام المعروضة ومما هو مصنوع ليصلوا إلى تكوين المفهوم بأنفسهم</td></tr>
<tr><td>كيفية القيام بالنشاط</td><td>قسم الطلبة إلى مجموعات
وزع أوراق النشاط بين الطلاب
اطلب من كل طالب منفرد أن يقوم بالإجراء الأول وهو تخمين انجذاب المواد للمغناطيس ثم بعد ذلك يناقش ذلك مع أفراد مجموعته.
وزع الأدوات على المجموعات واطلب منهم أن يختبروا كل مادة ثم يسجلون ملاحظاتهم مباشرة إلى أن ينتهوا من كل المواد في مدة لا تتجاوز 15 دقيقة.
تابع أداء التلاميذ للنشاط و سجل ملاحظاتك على أداءهم للنشاط
أعط كل طالب 5 دقائق ليستكمل إجاباته ويكتب التقرير الذاتي.
ناقش معهم فيما تبقى من الوقت إجاباتهم ثم اجمع أوراقهم ووزع عليهم الواجب</td></tr>
<tr><td>عمل النشاط</td><td>في مجموعات</td></tr>
<tr><td>معايير الإجابة</td><td>يفترض أن تعطيك محددات الإجابات التي تقوم الطالب على أساسها وكذلك تقويم الطالب لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات الطلاب</td></tr>
<tr><td>إعطاء الطالب عمل إضافي</td><td>خلال قيامك بملاحظة التلاميذ أثناء قيامهم بالنشاط ومتابعة ا داؤه م يمكن أن تحصل على فكره مبدئية عن تقدمهم لذلك تقويم أداء التلاميذ على (محددات الإجابة) سوف تكون أيسر أي تلميذ يحصل على تقدير(مرضي) أو اقل ينصح بإعطائه فرصه لتحسين عمله عن طريق طلب كتابه تقرير عن النشاط او إعطائه واجب إضافي يساعده على فهم الموضوع أو بكلا الاجرائين أما الطالب الذي ينتهي من عمله مبكرا فينصح بإعطائه نشاط إضافي</td></tr>
</table>

نشاط رقم (2)

قوة المغناطيس

Adapted from: Centre, J. G. (1991). *Hands-on science and technology : teaching science and technology in primary classrooms*: Hawthorn East, Vic.; Peters, J., & Gega, P. (2002). *Science in Elementary Education* (9th Edition ed.): Merrill Prentiee Hall, New Jersey Columbus, Ohio.

ورقة الطالب

الاسم .... المدرسة ....

معايير التقويم

معيار الأداء	1	2	3	4
كتب افتراضه لكيفية توزيع قوة المغناطيس				
سجل خطوات التحقق من الافتراض السابق				
قام بإجراء التجربة حسب الخطوات التي ذكرها				
استنتج أين تتركز قوة المغناطيس				
قام بخطوات الجزء الثاني من النشاط				
حدد المغناطيس الأقوى من الأشكال الثلاثة				
الدرجة الكلية				

____________تواصل مع المعلم بشكل مناسب.

____________شارك في أداء النشاط مع زملائه

____________أكمل نموذج التقويم الذاتي

____________استخدم الأدوات بشكل مناسب

____________اظهر قدر من المسؤولية تجاه نفسه وتجاه الآخرين.

توزع النقاط على الشكل التالي:

4 نقاط إذا كان العمل صحيحا ، كاملا ،و مفصلا

3نقاط إذا كان العمل معظمه صحيح ، كاملا ،ومفصلا

2نقاط إذا كان العمل صحيح لحد ما ، غير مكتمل و ينقصه بعض التفاصيل

1نقاط غير صحيح أو لم يكمل ويحتاج إلى مساعدة

ملاحظات المعلم

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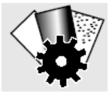
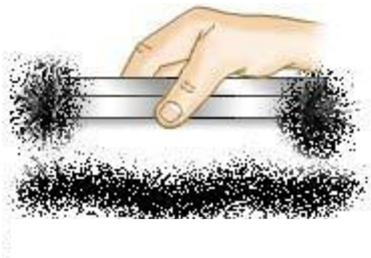
نشاط رقم (2)

لاحظت في النشاط السابق أن المغناطيس لديه القوه لجذب الأجسام المصنوعة من الحديد، ولكن هل هذه القوه متساوية في كل أجزاء المغناطيس؟ أم إنها تتركز في بعض أجزائه؟ هذا ما سوف تكتشفه بإجراء التجربة التالية.



الجزء الأول:



المواد: قضيب من المغناطيس ودبابيس أو مساكات ورق .

:هل تعتقد أن قوة المغناطيس تتوزع بالتساوي بين أجزاءه(على سبيل المثال بين أطرافه ووسطه) أم أنها أقوى في بعض الأجزاء كالوسط أو الأطراف؟

أكمل الفرض التالي أعتقد أن قوة المغناطيس . . . .

فكر مع زملائك في طريقة يمكن أن تتأكدوا منها بشكل عملي وباستخدام الأدوات التي أمامكم (المغناطيس والدبابيس) في التحقق من صحة الافتراض ، بعد أن تتفقوا على طريقة موحدة سجل الخطوات(لا تزيد عن 3 خطوات) :

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قم الآن بإجراء التجربة حسب الخطوات التي ذكرتها في النقطة السابقة، ثم سجل ملاحظاتك

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ماذا تستنتج من هذه الملاحظات

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الجزء الثاني

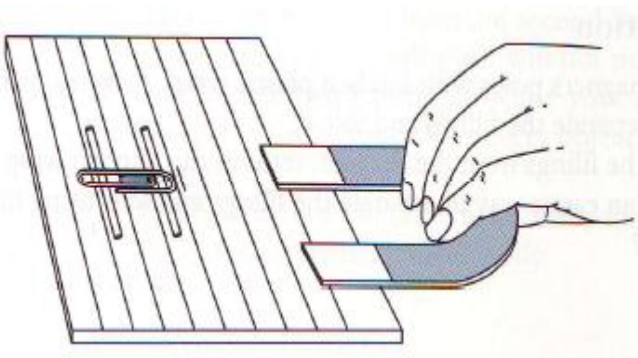
سقطت مفاتيح في مكان ضيق في قاع مسبح مملوء بالماء بحيث يصعب مسكها باليد أو أن تلامس مباشرة قضيب من المغناطيس مما يتطلب مغناطيس قوي يمكن أن يجذب من على بعد تلك المفاتيح من قاع المسبح.
المطلوب منك أن تحدد أي من المغناطيس أ،ب وجـ أقوى لاستخدامه لسحب المفاتيح

الأدوات :

3 أنواع من المغناطيس ، ورقة مخططة، قطعتين من مصاص عصير، مساكة ورق .

الخطوات:

ضع مساكة الورق على قطعتى المصاص المثبتة على الورقة المسطرة كما في الشكل التوضيحي



ارسم خط أمام مساكة الورق.

ضع المغناطيس على طرف الورقة وحركة تدريجيا باتجاه المساك

توقف عن تقريب المغناطيس إذا رأيت المساك يتحرك.

عد الخطوط التي بين المغناطيس والخط الذي رسمته وسجل الإجابة في الجدول تحت السؤال رقم (1).

كرر الخطوات السابقة مع بقية أشكال المغناطيس

اجب عن الاسئلة التالية:

كم عدد الخطوط الفاصلة بين المغناطيس و مساك الورق :

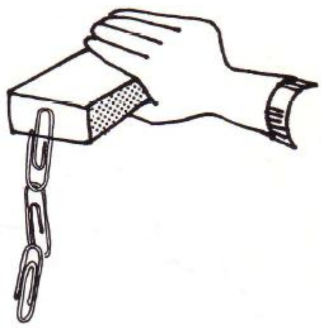
المغناطيس	عدد الخطوط
أ	
ب	
ج	

2- أي من الثلاث الأشكال من المغناطيس أقوى بحيث يمكن استخدامه لجذب المفاتيح من قاع المسبح ولماذا؟

نشاط رقم 2

نشاط إضافي

فكر في طريقة أخرى يمكنك أن تقيس بها قوة أشكال المغناطيس الثلاثة السابقة واشرح إجابتك.



التقويم الذاتي

ضع إشارة (√) تحت العبارة التى ترى أنها تعكس مستوى فهمك لهذا النشاط

4	3	2	1
قمت بكتابة افتراض لكيفية توزيع قوة المغناطيس بين أجزائه ناقشت مع زملاء كيف نعمل التجربة و سجلت الخطوات حسب المطلوب ☐	قمت بكتابة افتراض لكيفية توزيع قوة المغناطيس بين أجزائه و سجلت خطوات إجراء التجربة من دون أن أناقش زملائي في ذلك ☐	قمت بكتابة افتراض لكيفية توزيع قوة المغناطيس بين أجزائه ولكن لم أسجل خطوات التجربة ولم أشارك زملائي في النقاش ☐	لا اعرف كيف اكتب فرض أو تسجيل خطوات لإجراء التجربة ☐
استطيع ألان بعد إجراء التجربة أن احدد وبكل بساطة أين تتركز قوة المغناطيس ☐	استطيع الآن بعد إجراء التجربة أن احدد أين تتركز قوة المغناطيس ولكنى لست متأكدا من ذلك ☐	لا استطيع أن احدد بالضبط أين تتركز قوة المغناطيس ☐	لا اعرف كيف يمكنني تحديد أين تتركز قوة المغناطيس ☐
قمت بإجراء كل خطوات الجزء الثاني من النشاط ☐	قمت بإجراء معظم خطوات الجزء الثاني من النشاط ☐	قمت بإجراء بعض خطوات الجزء الثاني من النشاط ☐	لم أقم بتطبيق خطوات الجزء الثاني من النشاط ☐
قمت بقياس أشكال المغناطيس الثلاثة وتأكدت ما هو المغناطيس الأقوى ☐	قمت بقياس أشكال المغناطيس الثلاثة وحددت المغناطيس الأقوى ولكنى لست متأكد تماما من ذلك ☐	مع إني قمت بقياس قوة كل أشكال المغناطيس إلا أنى لم استطع أن احدد بالضبط ما هو المغنطيس الأقوى ☐	لا اعرف كيف أقيس قوة المغنطيس بهذه الطريقة ☐

إذا واصلت العمل في هذا النشاط سوف أحاول أن افهم

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أفضل ما تعلمت من هذا النشاط هو

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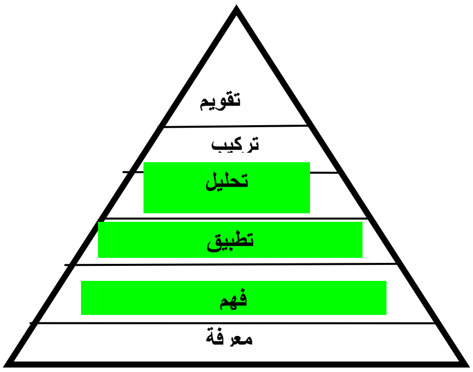
نشاط رقم 2

ورقة المعلم

التعليم الفعال	- أ يركز هذا النشاط على تعليم المعارف والمهارات التالية 1- مهارات المعرفة والتفكير: • كتابه فروض علمية • تصميم خطة لإجراء تجربة • إجراء تجربه • استنتاج • قياس 2- المحتوى المعرفي للنشاط: • أن يبين بالتجربة أن قوة المغناطيس تتركز في قطبيه. • يقيس قوة المغناطيس. • يقارن بين قوة أشكال مختلفة من المغناطيس ب- يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية • أن يبدي التلميذ اهتماما بإجراء التجارب العلمية . • أن يشارك التلميذ مع زملائه في نقاش علمي • أن يقدر التلميذ أهمية التخطيط لإجراء تجربة عملية 
وصف النشاط	في هذا النشاط سوف يقوم التلاميذ اولا بكتابة فرض عن قوة المغنطيس ، هذا الفرض سوف يعكس بطبيعة الحال خلفية التلميذ عن المغناطيس بعد ذلك سوف يقوم التلميذ مع مجموعته بمناقشة فروضهم ووضع خطة مبسطة لما سوف يقومون بأدائه للتأكد من الفروض التي وضعوها بعد أداء التجربة سوف يقوم التلاميذ بمناقشة النتائج ثم يسجل كل تلميذ بشكل منفرد على الاسئلة المطروحة في الجزء الثاني من النشاط المطلوب من التلميذ أن يقوم مع زملائه بقياس قوة ثلاثة أنواع من المغناطيس ويسجل كل منهم ملاحظاته في الجدول المخصص ثم بعد ذلك يجيب على بقية الأسئلة
كيفية القيام بالنشاط	قسم الطلبة إلى مجموعات وزع أوراق النشاط بين الطلاب اطلب من كل طالب منفرد أن يقوم بكتابة الفرض ثم بعد ذلك يناقش مع زملائه وضع خطة وتنفيذها. وزع الأدوات على المجموعات مع تحديد 10 دقائق لأداء الجزء الأول و15 دقيقة للجزء الثاني. تابع أداء التلاميذ للنشاط و سجل ملاحظاتك على أداءهم ساعد المجموعة التى تخلفت في أدائها بشكل غير مباشر عن طريق طرح بعض الاسئله عليهم. أعط كل طالب 5 دقائق ليستكمل إجاباته ويكتب التقرير الذاتي. ناقش معهم فيما تبقى من الوقت إجاباتهم ثم اجمع أوراقهم ووزع عليهم الواجب
عمل النشاط	في مجموعات
معايير الإجابة	يفترض أن تعطيك محددات الإجابات التي تقوم الطالب على أساسها وكذلك تقويم الطالب لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات التلاميذ

نشاط رقم (3)

أقطاب المغناطيس

Adapted from: Peters, J., & Gega, P. (2002). *Science in Elementary Education* (9th Edition ed.): Merrill Prentiee Hall, New Jersey Columbus, Ohio.

ورقة الطالب

الاسم.. .. .. المدرسة . . . .

معايير التقويم

معيار الأداء	1	2	3	4
أكمل كتابة الفروض العلمية للتجربة				
سجل كيفية التحقق تجريبيا من صحة الفرض الأول				
استنتج خاصية قطبي المغنطيس				
كتب خطوات تجريبية للتحقق من الفرض الثاني				
سجل ملاحظاته على التجربة				
توصل إلى أسمى قطبي المغناطيس				
الدرجة الكلية				

___________تواصل مع المعلم بشكل مناسب.

___________شارك في أداء النشاط مع زملائه

___________أكمل نموذج التقويم الذاتي

___________استخدم الأدوات بشكل مناسب

___________اظهر قدرا من المسؤولية تجاه نفسه وتجاه الآخرين.

___________أظهر اهتماما للقيام بنشاط في مادة العلوم

توزع النقاط على الشكل التالي:

4 نقاط إذا كان العمل صحيحا ، كاملا ،و مفصلا

3نقاط إذا كان العمل معظمه صحيح ، كاملا ،ومفصلا

2نقاط إذا كان العمل صحيح لحد ما ، غير مكتمل و ينقصه بعض التفاصيل

1نقاط غير صحيح أو لم يكمل ويحتاج إلى مساعدة

ملاحظات المعلم

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نشاط رقم(3)

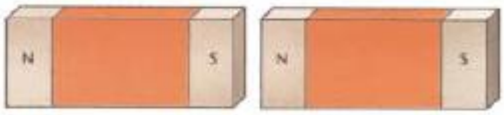
أقطاب المغناطيس

المغناطيس له طرفين تسمى قطبي المغناطيس في هذا النشاط سوف تقوم بإجراء تجربة ممتعة تتعرف من خلالها على :

- **الاختلاف أو التشابة بين قطبي المغناطيس.**
- **أسماء قطبي المغناطيس.**

الأدوات

قضيبين من المغناطيس، حاملا ، خيطا ، ورقة مسجل عليها الاتجاهات الأربعة.



الشرق

الشمال الجنوب

الغرب

1- الفروض أكمل

. . . . قطبي المغناطيس. . . . .(متشابهين، مختلفين).

إذا علق المغناطيس في حامل بحيث يكون حر الحركة سوف يتجه قطبيه إلى

. . . .(شمال جنوب ، شرق غرب)

2- ناقش مع زملائك خطة للتحقق بالتجربة من صحة الفرض الأول باستخدام قضيبي المغناطيس فقط ثم اكتب الخطوات أدناه

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3- بناء على مشاهداتك هل قطبي المغناطيس متشابهين أم مختلفين؟ ولماذا ؟

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4- ناقش مع زملائك خطة للتحقق بالتجربة من صحة الفرض الثاني و اكتب الخطوات

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5- سجل مشاهداتك للتجربة؟

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6- إذا كان طرفي المغناطيس تسمى أقطاب قم بتسمية قطبي المغنطيس بناء على اتجاهيهما

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التقويم الذاتي

ضع إشارة (√) تحت العبارة التى ترى أنها تعكس مستوى فهمك لهذا لنشاط

4	3	2	1
قمت بإكمال الفرضين (أ و ب) و ناقشت مع زملائي كيفية عمل تجربة كما سجلت الخطوات حسب المطلوب ☐	قمت بإكمال الفرضين (أ و ب) و سجلت خطوات إجراء التجربة من دون أن أناقش ذلك مع زملائي ☐	قمت بإكمال الفرضين (أ و ب) ولكن لم أسجل خطوات التجربة ولم أشارك زملائي في النقاش ☐	لا اعرف كيف اكتب فرض أو تسجيل خطوات لإجراء التجربة ☐
استطيع الآن بعد إجراء التجربة أن اشرح للآخرين كيف أن قطبي المغنطيس مختلفين ☐	تعرفت من خلال التجربة التى قمت بها لماذا قطبي المغنطيس مختلفين ولكن لا استطيع أن اشرح ذلك للآخرين ☐	اعرف أن قطبي المغناطيس مختلفين ولكن لا ادري لماذا ☐	لا اعرف كيف يمكنني التعرف على ما إذا كان قطبي المغنطيس متشابهين ام مختلفين ☐
ناقشت مع زملائي وضع خطة للتحقق من صحة الفرض الثاني وكتبت خطوات مفصلة لإجراء التجربة ☐	ناقشت مع زملائي وضع خطة للتحقق من صحة الفرض الثاني وكتبت بعض الخطوات لإجراء التجربة ☐	كتبت خطوات إجراء التجربة دون أن أناقش ذلك مع زملائي ☐	لم اكتب أي خطوات لإجراء التجربة ☐
الملاحظات التى سجلتها عن التجربة كانت مفصلة و واضحة ☐	الملاحظات التى سجلتها عن التجربة كانت مختصره و اعتقد أنها واضحة ☐	سجلت ملاحظات بسيطة عن التجربة ☐	لم أقم بتسجيل أي ملاحظات ☐

إذا واصلت العمل في هذا النشاط سوف أحاول أن افهم

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أفضل ما تعلمت من هذا النشاط هو

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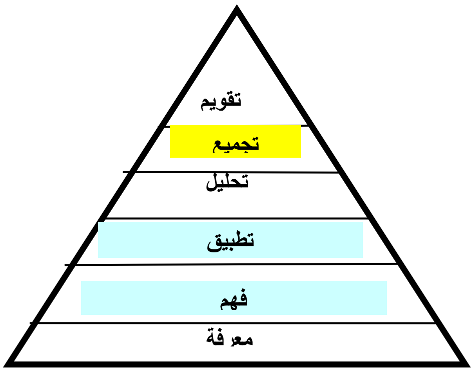
نشاط رقم (3)
قطبي المغنطيس
ورقة المعلم

التعليم الفعال	أ - يركز هذا النشاط على تعليم المعارف والمهارات التالية 1- مهارات المعرفة والتفكير: • كتابه فروض علمية • إجراء تجربه • الملاحظة • استنتاج 2- المحتوى المعرفي للنشاط: • أن يكتشف التلميذ بشكل عملي من أن قطبي المغناطيس مختلفان. • أن يسمى التلميذ قطبي المغنطيس ب-يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية : • أن يتدرب التلميذ على كيفية فرض الفروض والتحقق تجريبيا من صحتها • أن يتبنى التلميذ أسس المنهج العلمي عند دراسة الظواهر العلمية 
وصف النشاط	في هذا النشاط سوف يقوم التلاميذ بصياغة فرضين، الأول للتحقق مما إذا كان قطبي المغناطيس متشابهين أم مختلفين قد تتضمن خطة التلاميذ للتحقق من ذلك وضع احد المغناطيسيين على الطاولة وتقريب الآخر منه أو تعليق احديهما في الحامل أي كانت المحاولة فان اكتشاف التلاميذ لعملية التجاذب والتنافر بين أقطاب المغناطيس تعد محاولة ناجحة ليتبقى بعد ذلك عملية الاستنتاج بأن قطبي المغناطيس مختلفين وقد يكون الاستنتاج لبعض التلاميذ صعب مما يتعين عليك طرح بعض الاسئلة التي يمكن أن تقرب لهم هذا المفهوم الفرض الثانى للتحقق من اتجاه قطبي المغناطيس وليتوصل التلاميذ بأنفسهم إلى أسماء القطبين أن لم يكونوا يعرفوا أسماءهما من قبل أو للتحقق من سبب التسمية إذا كان لديهم معرفة سابقة بذلك
كيفية القيام بالنشاط	قسم الطلبة إلى مجموعات وزع أوراق النشاط بين الطلاب اطلب من كل طالب منفرد أن يقوم بالإجراء الأول وهو كتابة فرضي التجربة باختيار عبارة واحده من العبارات التى بين الأقواس وزع الأدوات على المجموعات واطلب منهم وضع خطة للتحقق مما تم افتراضه وتسجيلها مع إعطائهم مدة لا تتجاوز 15 دقيقة للتحقق من الفرض الأول. تأكد من إتمام التلاميذ للجزء الأول المتمثل في الإجابة على الفرض الأول قبل انتقالهم للتحقق من صحة الفرض الثاني في مدة لا تزيد عن 15 دقيقة. تابع أداء التلاميذ للنشاط و سجل ملاحظاتك على أداءهم أعط كل طالب 5 دقائق ليستكمل إجاباته ويكتب التقرير الذاتي. ناقش معهم فيما تبقى من الوقت إجاباتهم ثم اجمع أوراقهم ووزع عليهم الواجب .
عمل النشاط	في مجموعات
معايير الإجابة	يفترض أن تعطيك محددات الإجابات التي تقوم الطالب على أساسها وكذلك تقويم الطالب لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات الطلاب
إعطاء الطالب عمل إضافي	خلال قيامك بملاحظة التلاميذ أثناء قيامهم بالنشاط ومتابعة ا داؤه م يمكن أن تحصل على فكره مبدئية عن تقدمهم لذلك تقويم أداء التلاميذ على (محددات الإجابة) سوف تكون أيسر أي تلميذ يحصل على تقدير(مرضي) أو اقل ينصح بإعطائه فرصه لتحسين عمله عن طريق طلب كتابه تقرير عن النشاط أو إعطائه واجب إضافي يساعده على فهم الموضوع او بكلا الاجرائين أما الطالب الذي ينتهي من عمله مبكرا فينصح بإعطائه نشاطا إضافيا

شاط رقم (4)

البوصله

Adapted from : Aldridge, B., Croven, J., and Hunter, C.(1996), Teacher Materials: Learning Sequence Item:945 Magnetism, Scope, Sequence & Coordination. A national Curriculum Development and Evaluation Project for High School Science Education, http://dev.nsta.org/ssc/pdf/v4-0945s.pdf

ورقة الطالب

الاسم. .... المدرسة ....

معايير الأداء

معيار الأداء	1	2	3	4
قام بتحديد عناصر المشكلة				
قام مع زملائه بعرض طريقة لحلها				
وصف الخطوات التي اتبعها لحل المشكلة				
كان حله للمشكلة				
الدرجة الكلية				

__________تواصل مع المعلم بشكل مناسب.

__________شارك في أداء النشاط مع زملائه

__________أكمل نموذج التقويم الذاتي

__________استخدم الأدوات بشكل مناسب

__________اظهر قدرا من المسؤولية تجاه نفسه وتجاه الآخرين.

__________أظهر اهتماما للقيام بنشاط في مادة العلوم

توزع النقاط على الشكل التالي:

4 نقاط إذا كان العمل صحيحا ، كاملا ،و مفصلا

3نقاط إذا كان العمل معظمه صحيح ، كاملا ،ومفصلا

2نقاط إذا كان العمل صحيح لحد ما ، غير مكتمل و ينقصه بعض التفاصيل

1نقاط غير صحيح أو لم يكمل ويحتاج إلى مساعدة

ملاحظات المعلم

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نشاط رقم (4)

عدد من البحارة تاهوا في طريقهم في عرض البحر عندما كانوا يصطادون السمك وقد قضوا ساعات طويلة في التعرف على طريق العودة إلى الشاطىء ولكن دون جدوا احد البحارة قال ارشد ورى فقط على اتجاه الشمال وسوف أدلكم على طريق العودة بإذن الله لو افترضتا انك مع هؤلاء البحارة، كيف يمكن أن تستفيد من دراستك للمغناطيس في إرشادهم لاتجاه الشمال ؟

الأدوات التي يمكن أن تحتاجها هي قضيب مغناطيس، حوض مملوء بالماء، قطعة فلين، خيط، قلم رصاص (لاحظ ربما لا تحتاج إلى كل هذه الأدوات)

ناقش المشكلة مع زملائك واقترحوا بعد ذلك طريقة لحلها.

قوموا بتطبيق الطريقة التى اقترحتموها

المشكلة هي :

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الطريقة التي اقترحتها مع زملائي هي :

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صف الطريقة التي قمتم بتطبيقها للتعرف على اتجاه الشمال(يمكنك توضيحها بالرسم إذا رغبت)

ما اسم الأداة التي نتعرف بها على الاتجاهات ؟ . . . . .

إذا اقترح اسم للأداة التي اخترعتموها. . . . .

نشاط رقم (4)

نشاط إضافي

حاول أن تقترح طريقة أخرى لحل المشكلة السابقة

التقويم الذاتي

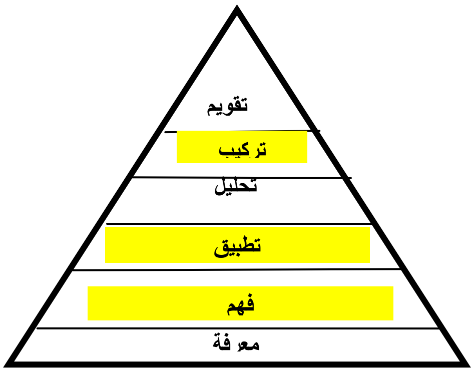
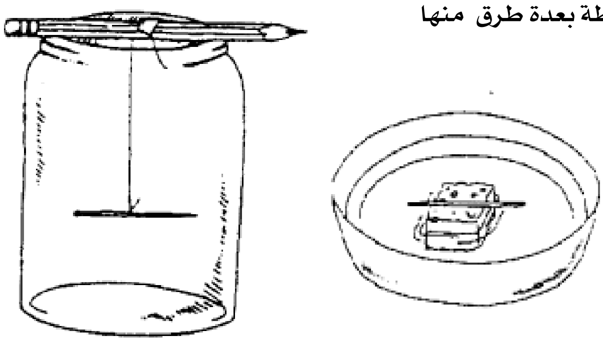
ضع دائرة على الرقم الذي تعتقد انه يعبر عن أدائك أو رأيك في لنشاط السابق على سبيل المثال إذا كنت ترى أن المشكلة بسيط ضع دائرة على رقم (4) ، إذا كنت ترى إنها بسيطة لحد ما ضع دائرة على رقم (3) أما إذا كنت ترى أنها صعبة فضع دائرة على رقم (1)

أستطيع أن اشرح هذه المشكلة	4	3	2	1	**لم افهم المشكلة**
أستطيع أن احدد العناصر المهمة والأجزاء غير المهمة في المشكلة	4	3	2	1	**لا أستطيع أن احدد العناصر المهمة أو غير المهمة في المشكلة**
أستطيع أن احل المشكلة واشرح طريقة الحل	4	3	2	1	**لا اعرف كيف ابدأ**
كانت هذه المشكلة بسيطة	4	3	2	1	**هذه المشكلة صعبة**

نشاط رقم (4)

البوصلة

ورقة المعلم

التعليم الفعال	- أ يركز هذا النشاط على تعليم التلميذ المعارف والمهارات التالية 1- مهارات المعرفة والتفكير: • إتباع خطوات حل المشكلة • إجراء تجربه • استنتاج • المحتوى المعرفي للنشاط: • أن يعمل التلميذ بوصلة . ب- يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية : • أن يدرك التلميذ أهمية المغناطيس التطبيقية. • أن يتدرب التلميذ على استخدام أسلوب حل المشكلات 
وصف النشاط	في هذا النشاط سوف يقوم التلاميذ بمواجهة مشكلة تتمثل في تحديد اتجاه الشمال باستخدام الأدوات المعروضة أمامهم من تلك الأدوات يمكن صنع بوصلة بسيطة بعدة طرق منها الطريقتين الموضحتين في الرسم : 
كيفية القيام بالنشاط	قسم الطلبة إلى مجموعات وزع أوراق النشاط بين الطلاب اطلب من كل مجموعة أن تحدد المشكلة كل طالب منفرد أن يقوم بالإجراء الأول وهو تخمين انجذاب المواد للمغناطيس ثم بعد ذلك يناقش ذلك مع أفراد مجموعته. وزع الأدوات على المجموعات واطلب منهم أن يختبروا كل مادة ثم يسجلون ملاحظاتهم مباشرة إلى أن ينتهوا من كل المواد في مدة لا تتجاوز 15 دقيقة. تابع أداء التلاميذ للنشاط و سجل ملاحظاتك على أداءهم للنشاط أعط كل طالب 5 دقائق ليستكمل إجاباته ويكتب التقرير الذاتي. ناقش معهم فيما تبقى من الوقت إجاباتهم ثم اجمع أوراقهم ووزع عليهم الواجب
عمل النشاط	في مجموعات
معايير الإجابة	يفترض أن تعطيك محددات الإجابات التي تقوم الطالب على أساسها وكذلك تقويم الطالب لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات الطلاب
إعطاء الطالب عمل إضافي	خلال قيامك بملاحظة التلاميذ أثناء قيامهم بالنشاط ومتابعة ا داؤه م يمكن أن تحصل على فكره مبدئية عن تقدمهم لذلك تقويم أداء التلاميذ على (محددات الإجابة) سوف تكون أيسر أي تلميذ يحصل على تقدير(مرضي) أو اقل ينصح بإعطائه فرصه لتحسين عمله عن طريق طلب كتابه تقرير عن النشاط أو إعطائه واجب إضافي يساعده على فهم الموضوع او بكلا الإجرائين أما الطالب الذي ينتهي من عمله مبكرا فينصح بإعطائه نشاط إضافي

نشاط رقم (5)

المغناطيس الكهربائي

Adapted from: Arevalo, R., Bortz, A., & Tse, T. (2003). *electromagnetism*, from www-2.cs.cmu.edu/People/rapidproto/students/abortz/project3/handout.pdf; Brubeck, T., Keim, R., & Thompson, K. *Get A Charge*: Illinois State Board of Education; Centre, J. G. (1991). *Hands-on science and technology : teaching science and technology in primary classrooms*: Hawthorn East, Vic.

. . . . الاسم . . . . .المدرسة . . . .

معايير التقويم

ممتاز	جيد جدا	جيد	يحتاج إلى تحسن
أجاب بشكل صحيح على كل الأسئلة كتب بشكل مفصل وصحيح التقرير عن التجربة	أجاب على معظم الأسئلة بشكل صحيح رسم بشكل واضح نسبيا المجال المغناطيسي للأشكال المطلوبة وضح الأماكن الصحيحة لتجمع برادة الحديد استدل بالتجربة على أسماء أقطاب المغناطيس لبعض الأماكن الخالية قدم تعريفا صحيحا للمجال المغناطيسي .	أجاب على بعض الاسئلة بشكل صحيح رسم بشكل غير واضح نسبيا المجال المغناطيسي للأشكال المطلوبة وضح الأماكن الصحيحة لتجمع برادة الحديد مع بعض الأخطاء لم يكتب يشكل صحيح أسماء أقطاب المغناطيس لمعظم الأماكن الخالية قدم تعريفا غير دقيق للمجال المغناطيسي.	معظم عمله غير صحيح ولا يرتبط بموضوع النشاط. إجابات فارغة

__________تواصل مع المعلم بشكل مناسب.

__________شارك في أداء النشاط مع زملائه

__________أكمل نموذج التقويم الذاتي

__________استخدم الأدوات بشكل مناسب

__________اظهر قدرا من المسؤولية تجاه نفسه وتجاه الآخرين.

__________أظهر اهتماما للقيام بنشاط في مادة العلوم

ملاحظات المعلم

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نشاط رقم (5)

المغناطيس الكهربائي

يوجد المغناطيس بشكل طبيعي كما يمكن أيضا صنعه بطرق مختلفة.

في هذا النشاط سوف تتعرف على طريقتين لصنع المغناطيس الأولى باستخدام الكهرباء والثانية عن طريق الدلك باستخدام مغناطيس آخر

الجزء الأول صنع المغناطيس الكهربائي(كهرومغناطيس).

الأدوات

بطارية جافة

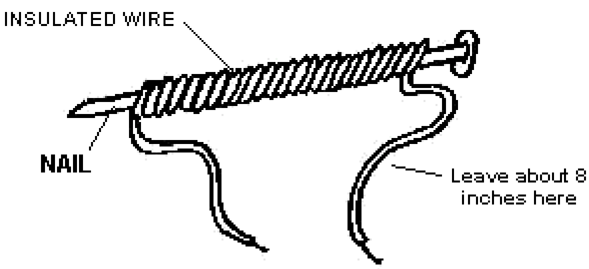
مسمار طويل

سلكا من النحاس بطول80سم تقريبا

دبابيس

الإجراءات :

لف السلك على المسمار بإحكام مع ترك حوالي 20 سم من كل طرف كما في الشكل.



صل طرفي السلك بقطبي البطارية

قرب طرف المسمار من الدبابيس ماذا تشاهد

....

. . . . افصل السلك عن البطارية ماذا تشاهد . . . .

الجزء الثاني صنع مغناطيس بالدلك

بافتراض أن لديك فقط مسمار ومغناطيس كيف يمكنك صنع مغناطيس؟

الأدوات مغناطيسا، مسمارين كبيرين ، دبابيس صغيرة

الإجراءات:

قرب طرف المسمار من الدبابيس.

. . . . هل جذب الدبابيس؟. . . . .

ادلك المسمار بقطب المغناطيس الشمالي بحيث يكون الدلك في اتجاه واحد كما في الشكل.

كرر عملية الدلك 20 مرة ثم قرب المسمار من الدبابيس.

. . . . كم عدد الدبابيس التى جذبها المسمار. . . . .

كرر عملية الدلك 30 مرة ثم قرب المسمار من الدبابيس.

. . . . .كم عدد.الدبابيس التي جذبها المسمار . . . .

. . . . إذا كلما ا.ازدادت عدد مرات الدلك كلما. . . . .

كرر ما سبق مع المسمارالثانى مستخدما القطب الجنوبي في عملية الدلك

. . . . .ماذا تشاهد . . . .

التقريرعن التجربة

1- الهدف من التجربة:

2- الإجراءات التي قمت بها والنتائ ج التي توصلت إليها

ما قمت بعملة في الجزء الأول (يمكن التوضيح بالرسم)	النتائج التي توصلت إليها
ما قمت بعملة في الجزء الثاني	النتائج التي توصلت إليها

نشاط رقم (5)

المغناطيس الكهربائي

نشاط إضافي

باستخدام أدوات الجزء الأول من التجربة كيف يمكن صنع مغناطيسا كهربائيا أقوى؟

التقويم الذاتي

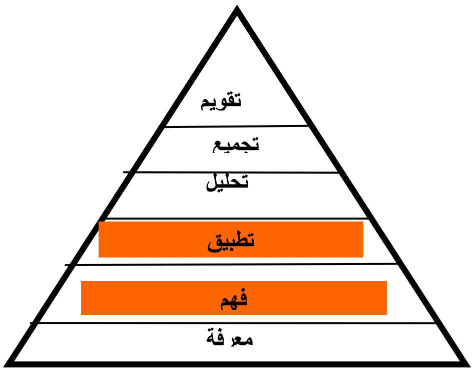
قدر مستوى أدائك لهذا النشاط بوضع (√) تحت العبارة التي ترى أنها تعبر عن مستوى أدائك الفعلي

4	3	2	1
قمت بتنفيذ كل إجراءات التجربة ☐	قمت بتنفيذ معظم إجراءات التجربة ☐	قمت بتنفيذ بعض إجراءات التجربة ☐	لم أنفذ التجربة ☐
أستطيع بكل سهولة أن اصنع مغناطيسا كهربائيا ☐	أستطيع أن اصنع مغناطيسا كهربائيا بإتباع تعليمات إجراءات التجربة ☐	أستطيع أن اصنع مغناطيسا كهربائيا بقليل من المساعدة ☐	لا أظن اننى أستطيع عمل مغناطيسا عن طريق الدلك ☐
أستطيع ببساطة أن اصنع مغناطيس بالدلك ☐	أستطيع أن اصنع مغناطيسا بالدلك عن طريق إتباع تعليمات إجراءات التجربة ☐	أستطيع أن اصنع مغناطيسا بالدلك بقليل من المساعدة ☐	لا أظن اننى أستطيع عمل مغناطيسا عن طريق الدلك ☐
كان هذا النشاط سهلا ☐	هذا النشاط سهلا لحد ما ☐	هذا النشاط فيه بعض الصعوبة ☐	هذا النشاط صعبا ☐

نشاط رقم (5)

صنع مغناطيس

ورقة المعلم

التعليم الفعال	أ - يركز هذا النشاط على تعليم المعارف والمهارات التالية 1- مهارات المعرفة والتفكير: • القيام بتجربة • الملاحظة • التوقع • كتابة تقرير المحتوى المعرفي للنشاط: • أن يصنع التلميذ مغناطيسا بطريقتين . • أن يصف التلميذ كيفية صنع المغناطيس ب- يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية • أن يبدي التلميذ اهتماما بعمل تجارب علمية وتسجيل ملاحظاته • أن ينمي التلميذ حب الاستطلاع لدراسة الظواهر العلمية 
وقت النشاط	30 دقيقة
وصف النشاط	في هذا النشاط سوف يقوم التلميذ مع زميل آخر بإجراء تجربة حسب التعليمات المعطاة لصنع مغناطيس مؤقت بطريقتين يستخدمان في الأولى بطارية وفي الثانية مغناطيس في نهاية التجربة سوف يقوم كل تلميذ بشكل منفرد بكتابة تقرير عن التجربة يصف فيه خطوات تحويل مسمار إلى مغناطيس حسب الطريقة التي قام بها
كيفية القيام بالنشاط	قسم التلاميذ إلى مجموعات زوجية إذا كانت الأدوات تكفي أو إلى مجموعات اكبر حسب العدد. وزع أوراق النشاط بين التلاميذ اطلب من كل مجموعة أن يتبعوا التعليمات بدقة تابع أداء التلاميذ مع حثهم على الإجابة على الأسئلة القصيرة التي تتضمنها الإجراءات. اطلب من التلاميذ أن يكتبوا التقرير عن التجربة ناقش معهم فيما تبقى من الوقت إجاباتهم ثم اجمع أوراقهم ووزع عليهم الواجب .
عمل النشاط	في مجموعات ويفضل عدد اقل قدر الإمكان
معايير الإجابة	يفترض أن تعطيك محددات الإجابات التي تقوم الطالب على أساسها وكذلك تقويم الطالب لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات الطلاب
إعطاء الطالب عمل إضافي	خلال قيامك بملاحظة التلاميذ أثناء قيامهم بالنشاط ومتابعة ا داؤه م يمكن أن تحصل على فكره مبدئية عن تقدمهم لذلك تقويم أداء التلاميذ على (محددات الإجابة) سوف تكون أيسر أي تلميذ يحصل على تقدير (مرضي) أو اقل ينصح بإعطائه فرصه لتحسين عمله عن طريق طلب كتابه تقرير عن النشاط او إعطائه واجب إضافي يساعده على فهم الموضوع او بكلا الاجرائين أما الطالب الذي ينتهي من عمله مبكرا فينصح بإعطائه نشاط إضافي

نشاط رقم(6)

المجال المغناطيسي

Adapted from: Peters, J., & Gega, P. (2002). *Science in Elementary Education* (9th ed.): Merrill Prentiee Hall, New Jersey Columbus, Ohio; htm http://galileo.phys.virginia.edu/education/outreach/8thgradesol/MagnetFrm.htm

الاسم. .. .. المدرسة . . . .

معايير التقويم

ممتاز	جيد جدا	جيد	يحتاج إلى تحسن
أجاب بشكل صحيح على كل الأسئلة رسم بشكل واضح تماما المجال المغناطيسي للأشكال المطلوبة وضح بدقة الأماكن الصحيحة لتجمع برادة الحديد استدل بالتجربة وبشكل صحيح على أسماء أقطاب المغناطيس في كل الأماكن الخالية قدم تعريفا شاملا للمجال المغناطيسي .	.أجاب على معظم الأسئلة بشكل صحيح رسم بشكل واضح نسبيا المجال المغناطيسي للأشكال المطلوبة وضح الأماكن الصحيحة لتجمع برادة الحديد استدل بالتجربة على أسماء أقطاب المغناطيس لبعض الأماكن الخالية قدم تعريفا صحيحا للمجال المغناطيسي .	أجاب على بعض الاسئلة بشكل صحيح رسم بشكل غير واضح نسبيا المجال المغناطيسي للأشكال المطلوبة وضح الأماكن الصحيحة لتجمع برادة الحديد مع بعض الأخطاء لم يكتب يشكل صحيح أسماء أقطاب المغناطيس لمعظم الأماكن الخالية قدم تعريفا غير دقيق للمجال المغناطيسي .	معظم عمله غير صحيح ولا يرتبط بموضوع النشاط. إجابات فارغة

___________تواصل مع المعلم بشكل مناسب.

___________شارك في أداء النشاط مع زملائه

___________تبادل المعلومات مع زملائه

___________اتبع كل التعليمات.

___________استخدم الأدوات بشكل مناسب

___________اظهر قدر من المسؤولية تجاه نفسه وتجاه الآخرين.

_______ سأل اسئلة مرتبطة بالموضوع

ملاحظات المعلم

....

....

....

....

....

نشاط رقم(6)

المجال المغناطيسي

هل لاحظت أن المغناطيس يجذب بعض الأجسام دون أن يلامسها مباشرة؟ هل سألت نفسك لماذا؟

حسنا أن ذلك بسبب وقوع تلك الأجسام ضمن مجال المغناطيس

على الرغم من عدم رؤية المجال المغناطيسي إلا أن هناك عدة طرق للتعرف عليه في هذا النشاط

سوف تكتشف بنفسك هذا المجال الذي يتخذ أشكالا جميلة.

المواد

مغناطيسا مستقيما وآخر حذوة حصان، ورقة ، برادة حديد.

الإجراءات:

1-ضع المغناطيس على الطاولة .

2- ضع ورقة بشكل افقى على المغناطيس بحيث يكون في وسط الورقة.

3- انثر برادة الحديد على الورقة بشكل تدريجي مع تحريك خفيف للورقة.

4- ارسم ما تشاهده في المستطيل رقم (1) .

(1)	(2)

5-في أي المناطق تجمعت برادة الحديد بشكل اكبر ولماذا؟

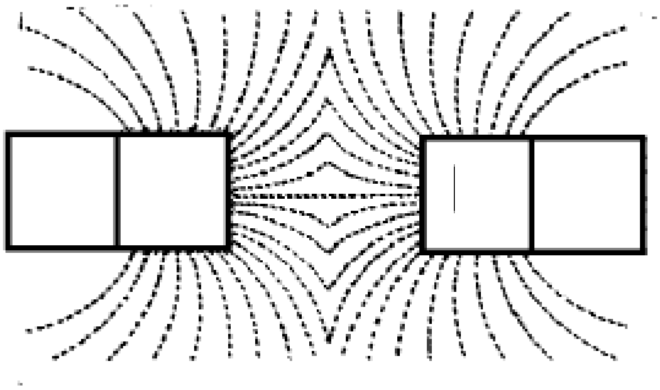
....

....

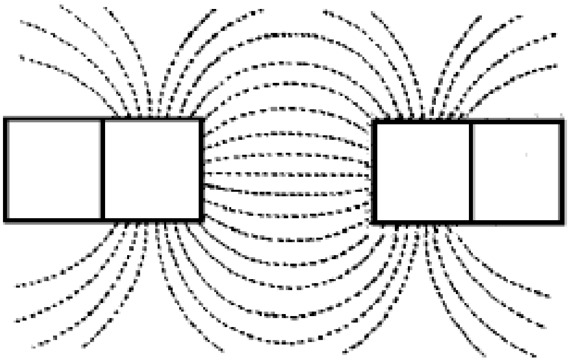
....

6- كرر ما سبق مع مغناطيس حذوة الحصان وارسم مشاهداتك في المستطيل رقم (2).

7-كرر التجربة السابقة باستخدام مغناطيسين مستقيمين وبناء على مشاهداتك استنتج أسماء أقطاب المغناطيس في الأماكن الخالية للأشكال التالية (استخدم "ش للقطب الشمالي و"ج للقطب الجنوبي):



شكل رقم (1)



شكل رقم (2)

- 8 ما هو المجال المغنطيسي؟

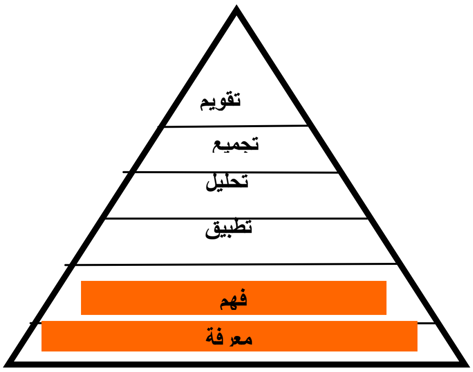
....

....

نشاط رقم (6)

المجال المغناطيسي

ورقة المعلم

التعلم الفعال	أ - يركز هذا النشاط على تعليم المعارف والمهارات التالية 1- مهارات المعرفة والتفكير: • الملاحظة • الرسم • الاستنتاج 2 المحتوى المعرفي للنشاط: • أن يرسم الطالب المجال المغناطيسي. • أن يصف التلميذ المجال المغناطيسي ب- يدعم هذا النشاط تحقيق الأهداف الوجدانية التالية • أن ينمي التلاميذ حب الاستطلاع والاستكشاف لخصائص المغناطيس. • أن يبحث عن دليل علمي لطرح استنتاجاته 
وصف النشاط	في هذا النشاط سوف يقوم التلاميذ بإجراء تجربة بسيطة باستخدام مغناطيسين مستقيمين وثالث على شكل حذوة الحصان مع برادة الحديد لمشاهدة المجال المغناطيسي والقيام برسمه ثم بعد ذلك التعرف على أقطاب المغناطيس للأشكال المعطاة باستخدام قضيبي المغناطيس وكتابة ذلك في الأماكن الخالية في الشكل رقم (2) يعبر الشكل عن قطبين مختلفين وفي الشكل رقم (1) تعبر عن قطبين متشابهين
كيفية القيام بالنشاط	قسم التلاميذ إلى مجموعات وزع أوراق النشاط بين الطلاب اطلب من كل مجموعة أن يتبعوا التعليمات بدقة إذا ظهر شكل المجال المغناطيسي بشكل واضح اطلب من كل تلميذ أن يرسمه في المكان المخصص ، قم يتبعه بعد ذلك بمغناطيس حذوة الحصان. للإجابة على السؤال السابع اطلب من التلاميذ أن يقوموا بعدة محاولات مستخدمين في ذلك المغناطيسين المستقيمين في اتجاهات مختلفة إلى أن يحصلوا على شكل مقارب لكل شكل معطى. دع التلاميذ لمدة 5 دقائق يتناقشوا للإجابة على السؤال الأخير ناقش معهم فيما تبقى من الوقت إجاباتهم ثم اجمع أوراقهم ووزع عليهم الواجب .
عمل النشاط	في مجموعات
معايير الإجابة	يفترض أن تعطيك محددات الإجابات التي تقوم الطالب على أساسها وكذلك تقويم الطالب لنفسه تغذيه راجعه تقوم على أساسها بمراجعة عملك وتطويره لتلافي السلبيات كذلك يتوقع أن تستفيد من عمليه التقويم للأغراض التشخيصية ومعرفة حاجات الطلاب
إعطاء الطالب عمل إضافي	خلال قيامك بملاحظة التلاميذ أثناء قيامهم بالنشاط ومتابعة ا داؤه م يمكن أن تحصل على فكره مبدئية عن تقدمهم لذلك تقويم أداء التلاميذ على (محددات الإجابة) سوف تكون أيسر أي تلميذ يحصل على تقدير(جيد) أو اقل ينصح بإعطائه فرصه لتحسين عمله عن طريق طلب كتابه تقرير عن النشاط او إعطائه واجب إضافي يساعده على فهم الموضوع او بكلا الاجرائين أما الطالب الذي ينتهي من عمله مبكرا فينصح بإعطائه نشاط إضافي

اكتشف المغناطيس الأقوى

Adapted from: Magnet, Chapter1, Students Achievement on The Performance Assessment Tasks, TIMSS,1995, http://timss.bc.edu/timss1995i/TIMSSPDF/PAchap1a.pdf

الاسم ______________________ **المدرسة** ______________________

الأدوات

- 6 كرات من الاستيل
- 10 دبابيس (مساكات ورق)
- قضيبين استيل
- 2قضيب حديد
- 2 مغناطيس
- مسطرة 30سم

ما يجب عليك عمله:

استخدم الأدوات التي أمامك لتحديد أي مغناطيس أقوى (أ) أو (ب)

اختبر كل مغناطيس على الأقل بطريقتين وأكمل الجملة التالية:

وجدت أن المغناطيس . . . . . أقوى . . . .

صف طريقتين استخدمتها لتحديد المغناطيس الأقوى يمكن استخدام الرسم لتوضيح إجابتك إذا رغبت

	ما قمت بعمله	النتيجة التي حصلت عليها
الاختبار الأول **المغناطيس (أ)** **المغناطيس (ب)**		
الاختبار الثاني **المغناطيس (أ)** **المغناطيس (ب)**		

معايير التقويم

الفقرة(1) تحديد المغناطيس الأقوى حدد بشكل صحيح المغناطيس الأقوى بناء على ملاحظات المعلم

الدرجة الكلية:4

الفقرة(2) وصف طريقتين استخدمهما التلميذ لتحديد المغناطيس الأقوى:

سجل ما قام بعمله في كل مره اختبر فيها كل مغنطيس

ربط نتائج كل اختبار بتحديد المغناطيس الأقوى

الدرجة لكل وصف صحيح :1 الدرجة الكلية:4

المغناطيس

مهمة رقم (2)

Adapted from: Oregon State Department of Education

المواد

دبابيس

مسامير

أغطية قوارير أو علب

مساكة ورق

عملة معدنية

لوح خشبي

أنواع مختلفة الأشكال والأحجام من المغناطيس

ازارير

مقياس (مسطرة)

التعليمات

في هذا النشاط سوف تجيب على السؤال التالي:

من خلال أي من المواد المعروضة أمامك يمكن أن يجذب المغناطيس الدبابيس؟

للإجابة على هذا السؤال سوف تحتاج للقيام بعملية تقصي علمي (أي أن تبحث وتكتشف بنفسك) لتتأكد من ما إذا كان المغناطيس يمكن أن يجذب الدبابيس من خلال المواد أم لا ؟

عند التخطيط للقيام بذلك، فكر في الأمور التالية:

ما الشيء الذي سوف تغيره باستمرار في بحثك وما الشيء الذي ستجعله ثابتا طوال الوقت

كيف يمكن أن تتأكد من أن المسافة بين المغناطيس والدبابيس ثابتة ومناسبة؟

اذكر بالترتيب الخطوات التي سوف تقوم بها، يمكنك أن تستعين بالرسم لتوضيح تلك الخطوات تأكد من أن الخطوات التي كتبتها واضحة ومفصله بحيث يمكن لأي شخص آخر القيام بها بسهولة.

قم بإعداد جدول أو رسم بياني لتسجل به ملاحظاتك ونتائجك.

ابدأ بتنفيذ الخطوات التي ذكرتها إذا غيرت احد الخطوات سجل ذلك واذكر لماذا غيرتها.

سجل ملاحظاتك وقياساتك حاول أن تحولها إلى شكل بياني إذا رغبت في عمل ذلك.

فسر النتائج التي توصلت إليها بين ما إذا كانت النتائج التي توصلت إليها ناقصة.

بناء على ما قمت به والنتائج التي توصلت إليها، اكتب بعض الاسئلة التي يمكن الإجابة عليها من خلال القيام بمزيد من التجارب

الواجب المنزلي لوحدة المغناطيس

مادة العلوم

الاسم ______________________ المدرسة ______________________

تعليمات القيام بالواجبات:

1 - يتضمن الواجب العديد من الأسئلة التى يفترض أن تحلها خلال أسبوع وتعيدها لمعلمك في بداية الأسبوع التالي.

2 - لا تقم بحل كل الأسئلة مرة واحدة، ولكن بعد كل حصة علوم قم بحل الأسئلة المرتبطة بموضوع الحصة.

3 - يهدف الواجب المنزلي إلى ترسيخ فهمك للموضوعات التى أخذتها في المدرسة أو فهم ما لم تتمكن من فهمه في وقت الحصة، لذا احرص دائما على أدائه وتسليمه في الوقت المناسب.

4 - إذا لم تستطع أو لم تفهم أحد الأسئلة يمكنك أن تسأل المعلم أو أحد أفراد أسرتك لشرح ما أشكل عليك فهمه وبعد ذلك قم بحل السؤال بنفسك.

5 - أداؤك للواجب سوف يصحح وفق الجدول التالي:

معايير التقويم

4	• **سلم الطالب الواجب في الوقت المحدد** • **أجاب على كل الأسئلة إجابات صحيحة ودقيقة.** • **أوراق الواجب نظيفة و مكتوب بخط واضح** • **أعتمد على نفسه في عمل الواجب**
3	• **سلم الطالب الواجب في الوقت المحدد** • **أجاب على معظم الأسئلة إجابات صحيحة ودقيقة.** • **أوراق الواجب نظيفة إلا أن الخط غير واضح** • **أعتمد على نفسه في عمل الواجب**
2	• **سلم الطالب الواجب بعد يوم من موعده** • **أجاب على كل أو معظم الأسئلة إجابات صحيحة ودقيقة.** • **أوراق الواجب ليست نظيفة تماما** • **أعتمد على نفسه في عمل الواجب**
1	• **تأخر الطالب في تسليم الواجب.** • **أجاب على بعض الأسئلة إجابات صحيحة** • **أوراق الواجب ليست نظيفة** • **لم يعتمد على نفسه كليا في عمل الواجب**
صفر	**سوف يعطى وقتا إضافيا لإكمال أو إعادة عمل الواجب**

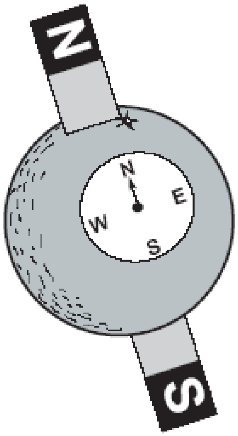
ملاحظات المعلم

....

....

ما المغناطيس؟

المغناطيس هو جسم يجذب بعض المواد كالحديد أو المواد التى تحتوى على الحديد كالاستيل هذه القوة الجاذبة تسمى المغناطيسية المغناطيس الطبيعي اكتشف منذ حوالي 600 سنة قبل الميلاد كان عبارة عن قطع من الصخر تجذب الحديد والصخور الأخرى المشابهه، هذه الصخور كانت تقع بقرب مدينة صغيره تسمى مغنيسيا.



المغناطيس له قطبين احدهما يسمى القطب الجنوبي والآخر يسمى القطب الشمالي القطب الشمالي يتنافر مع القطب الشمالي لأي مغناطيس آخر ولكنه يتجاذب مع القطب الجنوبي إذا يمكن القول أن الأقطاب المتشابهة تتنافر والأقطاب المتضادة كالقطب الشمالي والجنوبي تتجاذب ولكن لماذا سمي القطب الشمالي بهذا الاسم وما علاقة الشمال أو الجنوب بأقطاب المغناطيس ؟ لعلك تعرفت على إجابة هذا السؤال عند قيامك بالنشاط الثالث أحد أقطاب المغناطيس تتجه دائما إلى اتجاه الشمال للكره الأرضية بينما يتجه القطب الآخر لاتجاه الجنوب للكرة الأرضية ولذلك سمى القطب الجنوبي.

1-بعد قراءة القطعة اجب عن الاسئلة التالية :

أ - لماذا سمي المغناطيس بهذا الاسم:

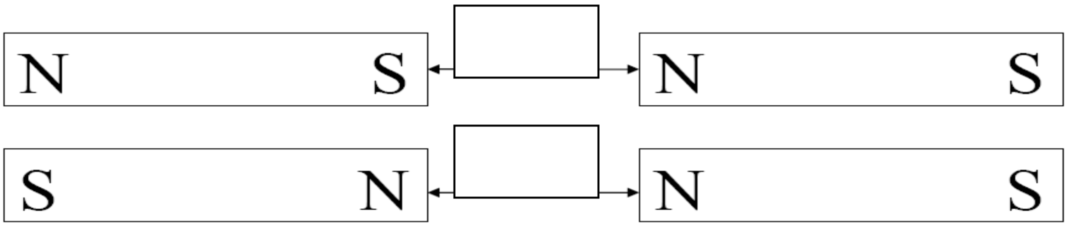
ب - ما هي المواد التي يجذبها المغناطيس:

ج - ماذا تسمى أقطاب المغناطيس:

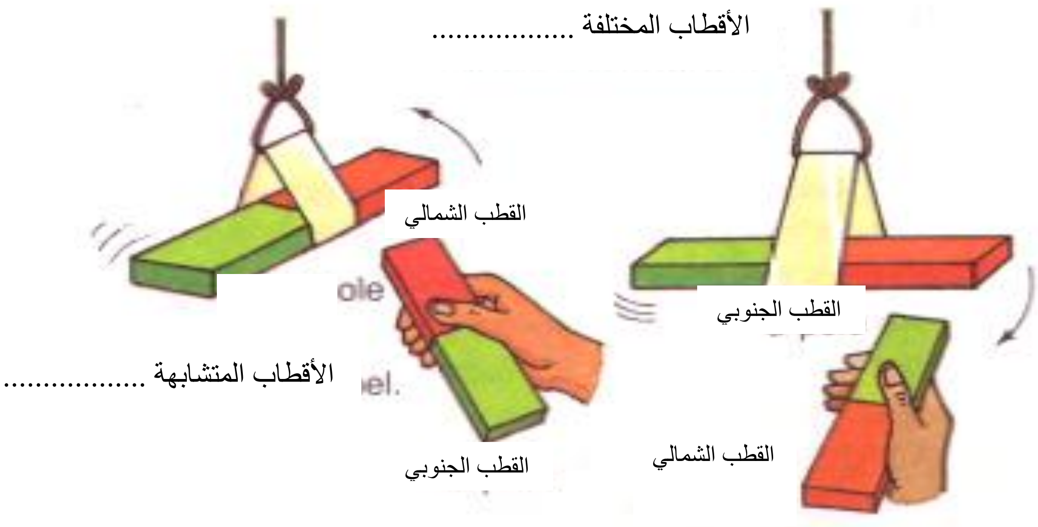
د - القوة الناجمة عن المغناطيس تسمى القوة -

1. الكهربائية
2. الحرارية
3. المغناطيسية
4. الشمسية

2-اكتب في المستطيل ما إذا كان المغناطيسين يتجاذبان أو يتنافران



3- أكمل الجمل الناقصة في الشكل التالي:



4-بين ما سيحدث لقطبي مغناطيسين (أو ب) عندما يتم تقريب احدهما من الآخر بالطرق التالية :

القطب الشمالي للمغناطيس (أ) مع القطب الجنوبي للمغناطيس (ب) ....

القطب الشمالي للمغناطيس (ب) مع القطب الشمالي للمغناطيس (أ) ....

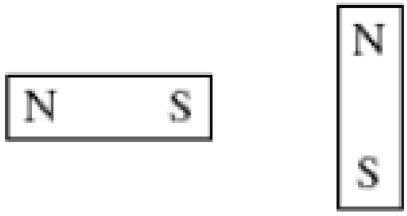
القطب الجنوبي للمغناطيس (أ) مع القطب الجنوبي للمغناطيس (ب) ....

5-اشرح كيف يمكن أن تحدد القطبين الشمالي والجنوبي للمغناطيس (أ) الذي لم يكتب عليه أسماء القطبين باستخدام المغناطيس (ب) ؟

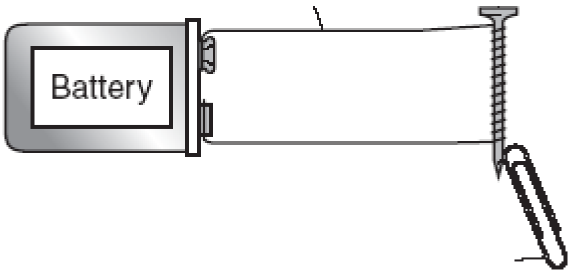
المغناطيس ب

المغناطيس أ

6 - قرب مغناطيسين من بعضهما كما في الشكل التالي وصف مع الرسم ما يحدث



7- قام أحد الطلاب ببناء دائرة كهربائية كما في الشكل المبين مستخدما سلك لفه حول مسمار من الحديد ووصله ببطارية المسمار أصبح ممغنط وجذب مساكة الورق كما ترى في الشكل



في هذه التجربة التى قام بها الطالب ،أي نوع من الطاقة مغنط المسمار (أي جعله مغناطيسا) الطاقة:

أ الكهربائية

ب الضوئية

ج الكيميائية

د الحرارية

8-أي معدنين مما يلي ينجذب للمغناطيس:

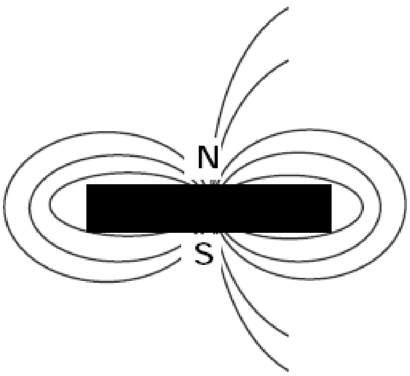
أ الحديد والاستيل

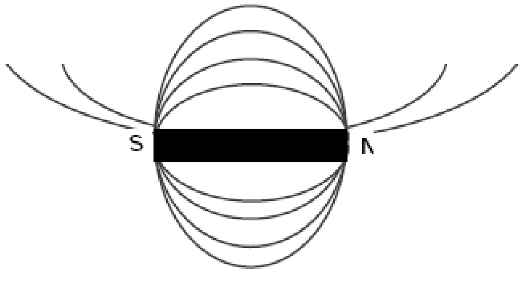
ب الذهب والفضة

ج - الالمنيوم والرصاص

المجال المغناطيسي

المنطقة المحيطة بالمغناطيس التى تتأثر فيها الأجسام القابلة للمغنطة ، كالحديد بقوة المغناطيس تدعى المجال المغناطيسي هذا المجال بطبيعة الحال غير مرئي بمعنى لا يمكن مشاهدته ولكن يمكن ألتعرف عليه عندما تنجذب بعض الأجسام التي تتكون من الحديد إلى المغناطيس أو تنفر منه كلما ابتعد الجسم عن المغناطيس كلما قلت قوة جذب المغناطيس له وعند ابتعاد هذا الجسم إلى نقطة لا ينجذب فيها للمغناطيس ففي هذه الحالة يمكن القول أن الجسم خارج المجال المغناطيسي شكل المجال المغنطيسي يعتمد على موقع القطبين الشمالي والجنوبي في المغناطيس ويمكنك التعرف على المجال المغناطيسي بأخذ مغناطيس ووضع قطعة من الورق عليه وبعد ذلك رش على الورقة برادة الحديد ، البرادة سوف تشكل المجال المغناطيسي الذي قد يكون كما في الشكلين التاليين أدناه





بعد قراءة القطعة اجب عن الاسئلة التالية:

1-ما المجال المغناطيس ؟

2-كيف يمكن التعرف على المجال المغناطيسي؟

3- اجب بـ (√) للفقرات الصحيحة و (×) للفقرات الخاطئة فيما يلي:

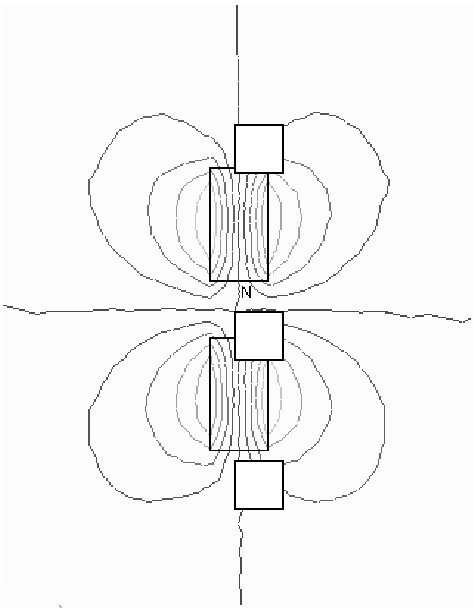
أ تزداد قوة المجال المغناطيسي كلما ابتعد الجسم عن المغناطيس ( )

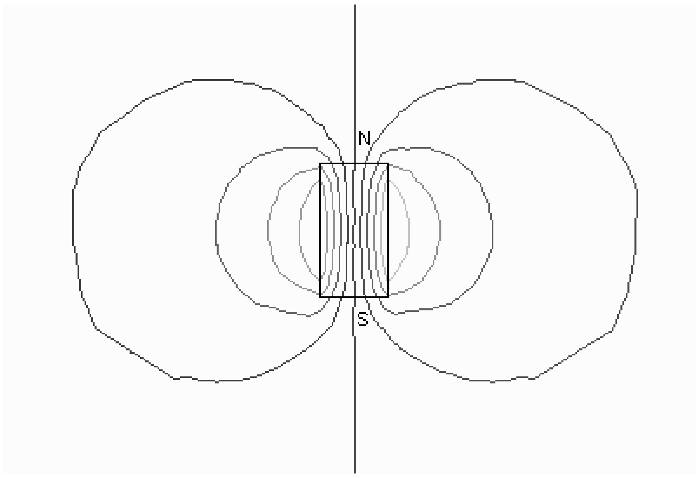
ب يتوقف شكل المجال المغناطيسي لأي مغناطيس على موقع القطبين فيه ( )

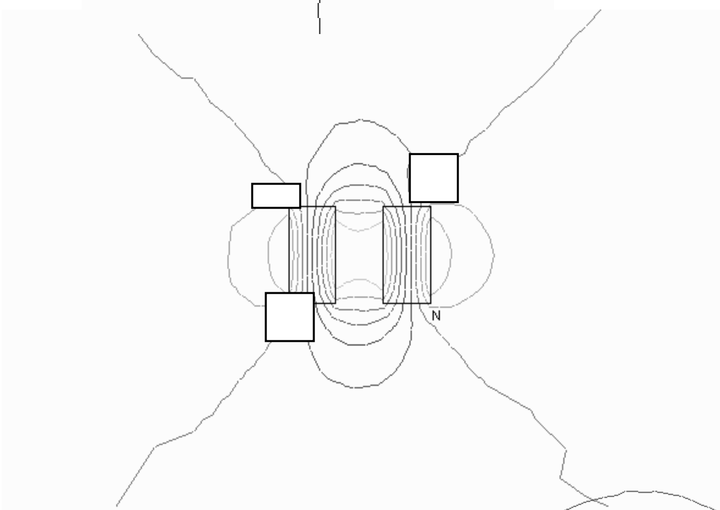
ج المجال المغناطيسي يمكن رؤيته بالعين ( )

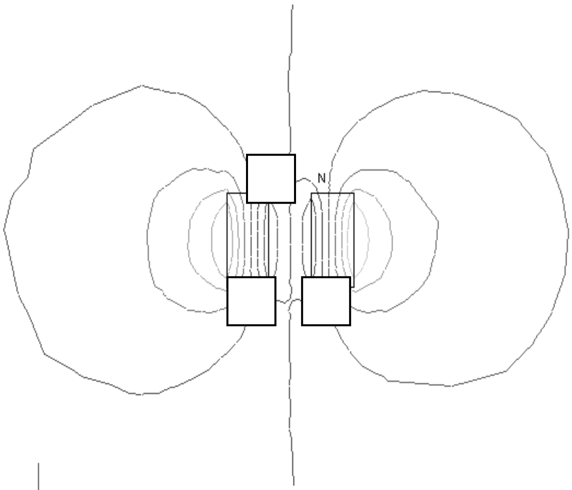
د كلما ازدادت قوة المغناطيس كلما ازدادت قوة مجاله المغنطيسي ( )

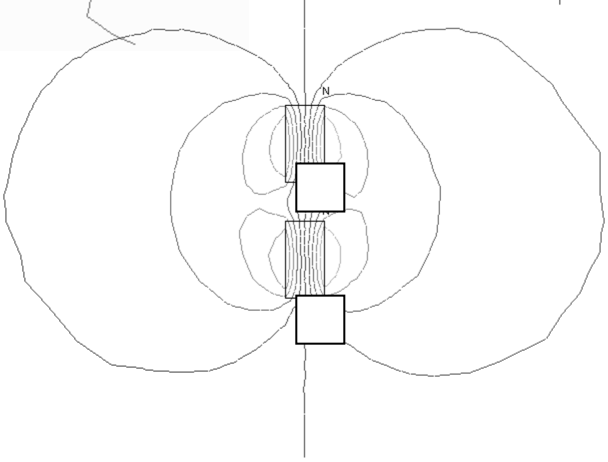
4- أمامك عدة أشكال توضح المجال المغنطيسي لقضيب من المغناطيس أو أكثر في أوضاع مختلفة . اكتب أسماء أقطاب المغناطيس في المربعات الخالية لكل شكل مستخدما حرف (N) للإشارة إلى القطب الشمالي و حرف (S) للإشارة إلى القطب الجنوبي



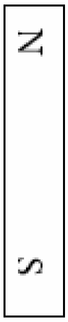


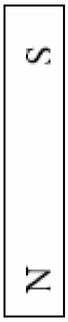






5-مستعينا بالأشكال السابقة أو بالقيام بتجربة عملية ارسم المجال المغنطيسي للمغناطيسين التاليين:





ملاحظة : لمزيد من المعلومات عن حركة المجال المغنطيسي اطلب من احد أفراد أسرتك أن يساعدك على الدخول على الموقع التالي: http://my.execpc.com/~rhoadley/motion00.htm

استخدامات المغناطيس

فيماذا يستخدم المغناطيس ؟

يوجد مئات الاستخدامات للمغناطيس منها البسيطة كتثبيت بعض الأشكال أو الصور على الثلاجة والمعقدة كتوليد الطاقة الكهربائية و تسيير القطارات

عدد بعض استخدامات المغناطيس مع إلصاق بعض الصور للأجهزة أو الأدوات التي يستخدم فيها المغناطيس؟

حقيبة تدريبية على برنامج التقويم المعتمد على الأداء

إعداد

عبدالله بن صالح السعدوي

إشراف

البروفسور موريين رايان

الدكتور انتونى وات

أهداف الورش التدريبية

يتوقع من المتدرب بعد إتمام هذه الورش التدريبية -

1 - أن يتعرف على كل من التقويم التقليدي و البديل ويميز بينهما

2 - أن يتعرف على أهمية التقويم المعتمد على الأداء كعنصر محوري لتطوير ممارسات التقويم التربوي

3 - أن يكون قادرا على دمج إجراءات التقويم مع كل من طرق التدريس ومنهج العلوم للصف السادس الابتدائي

4 - أن يصمم درس في العلوم بناء على استراتيجيات تقويم الأداء

5 - أن يتعرف على الأساليب المختلفة للتقويم الأدائي

6 - أن يصمم ويطبق في الصف الدراسي أنشطة ومهام تتطلب عمليات عقلية عليا وبعض المهارات التطبيقية

7 - أن يكون قادرا على استخدم أساليب التقويم البديل التي تعرف عليها لتقويم أداء التلاميذ

8 - أن يدير الصف بفاعلية معتمدا بشكل أساسي على أساليب التعلم التعاوني

9 - أن يكون أكثر وعيا بأهمية مراعاة الفروق الفردية بين التلاميذ

10 أن يستخدم أسلوب الملاحظة لمتابعة أداء التلاميذ

الورشات التدريبية

تحتوى هذه الحقيبة على عشر ورش عمل ، تتضمن كل ورشة على أهداف الورشة ، والمواد اللازمة لتنفيذها وجدولها الزمنى ، بالإضافة إلى مجموعة من الأنشطة المحددة بزمن يطلب من المتدربين تنفيذها

مدة الدورة التدريبية : (8) أيام بواقع (6) ساعات يوميا

والجدول التالي يوضح الورشات التدريبية والوقت المقدر لكل منها

الورشة	الوقت المقدر بالدقائق
1. التعريف بالتقويم المعتمد على الأداء	230
2. متطلبات تطبيق التقويم المعتمد على الأداء	230
3. تصميم و تنقيح مهام تقويمية لوحدة الكهرباء	230
4. يتبع الورشة السابقة	230
5. تصميم وتنقيح أساليب تقويمية أخرى(مشاريع وسجل التقويم)	230
6. تصميم وتنقيح مهام تقويمية لوحدة المغناطيس	230
7. عمل المجموعات	180
8. تقدير صعوبات تطبيق البرنامج	230

الفئة المستهدفة

معلمو العلوم المشاركون في تطبيق برنامج التقويم المعتمد على الأداء على تلاميذ الصف السادس الابتدائي

أسلوب العمل في الورش

على شكل مجموعات من (3- 5) أفراد في كل مجموعة حيث يقوم أعضاء كل مجموعة بمناقشة النشاط المطروح بهدف الوصول بعد ذلك إلى رأي موحد يلخص ثم يقدم أمام المجموعات الأخرى

ورشة رقم (1)

مقدمه في التقويم المعتمد على الأداء

أهداف الورشة

يتوقع من المتدرب بعد حضور هذه الورشة أن:

1 - **يتعرف على سلبيات استخدام أساليب التقويم التقليدي.**

2 - **يتعرف على مدخل التقويم المعتمد على الأداء.**

3 - **يعرف ويصف بعض أساليب التقويم الأدائي**

جدول الورشة الزمني

النشاط رقم	الفعالية	الزمن بالدقائق
(1)	تسجيل ملاحظات وطرح أسئلة بناء على مشاهدة عرض عن التقويم الأدائي	60
(2)	التعرف على سلبيات استخدام أساليب التقويم التقليدي	60
(3)	وصف التقويم الأدائي	60
(4)	مناقشة بعض أساليب التقويم الأدائي	50

نشاط (1- 1)

سوف تستمع إلى عرض عن التقويم المعتمد على الأداء يمكنك اخذ بعض الملاحظات أو طرح بعض الأسئلة في نهاية العرض

نشاط (1- 2)

تعرضت أساليب التقويم التقليدي للعديد من الانتقادات التي أدت إلى التفكير في البحث عن أساليب بديله الملحق(1- 1) يستعرض بعض تلك الانتقادات التي يعتقد بأنها أثرت بشكل سلبي على عناصر العملية التعليمية .إ قرآ الملحق(1- 2) ثم قم بالتالي :

1 - **لخص الأفكار الأساسية التي يتضمنها في عناصر محددة.**

2 -**أضف ما تراه إلى تلك العناصر من واقع خبرتك.**

3 -**ناقش ما توصلت إليه مع مجموعتك**

ملحق (1- 2)

الإطار المرجعي للتقويم التربوي ، الدوسري(2000)،ص140- 141.

نشاط رقم (1- 3)

لعلاج سلبيات أساليب التقويم التقليدي التي تم مناقشتها في النشاط السابق استحدثت العديد من أساليب التقويم التي تسمى عادة "بالتقويم البديّل ومن أبرز صوره *التقويم المعتمد على الأداء* بل أن البعض يرى أن التقويم الأدائي يمثل المظلة التي تندرج تحتها كل أساليب التقويم البديل في هذا النشاط سوف تقوم بالاشتراك مع أعضاء مجموعتك بالتالي:

1 - **تعريف التقويم المعتمد على الأداء.**
2 - **تحديد أهم خصائصه.**

ملحق(1- 3)

مقدمه في برنامج التقويم المعتمد على الأداء.

نشاط رقم (1- 4)

يتضمن التقويم المعتمد على الأداء عدة أنواع لكل منها خصائصه واستخداماته بالتعاون مع أفراد مجموعتك عدد بعض أنواع التقويم الأدائي مع ذكر خصائص كل نوع والمجال الأمثل لاستخدامه.

ملحق(1- 4)

مقدمه في برنامج التقويم المعتمد على الأداء.

ورشة رقم (2)

متطلبات تطبيق التقويم المعتمد على الأداء

أهداف الورشة

يتوقع من المتدرب بعد حضور هذه الورشة أن:

1 يكون قادرا على استخدام بعض أساليب التقويم الصفي بشكل تكاملي مع بقية عناصر العملية التعليمية.

2 يتعرف على مميزات استخدام المدخل البنائي في التعليم والتدريس .

3 يكون قادرا على استخدام أحدث طرق التدريس.

4 يستخدم التقويم الأدائي لأغراض تكوينية

جدول الورشة الزمني

النشاط رقم	الفعالية	الزمن بالدقائق
(1)	دمج التقويم مع عمليات التدريس والمنهج	60
(2)	تبني المدخل البنائي في التدريس	60
(3)	تطبيق أساليب حديثه للتدريس	60
(4)	استخدام التقويم للأغراض التكوينية	60

نشاط (2- 1)

يمثل التكامل والدمج بين مكونات العملية التعليمية الثلاث التدريس والتقويم والمنهج احد أهم سمات التربية الحديثة ناقش مع أفراد مجموعتك كيف يمكن دمج العناصر الثلاث وما الفائدة من ذلك.

ملحق(2- 1)

مقدمة في برنامج التقويم المعتمد على الأداء، ص9.

Integrating Assessment with Instruction

(http://www.nwrel.org/assessment/toolkit98/chapter2.html)

نشاط(2- 2)

أدى تطبيق مفاهيم النظرية البنائية في التعليم إلى العديد من النتائج الايجابية التى ظهرت بشكل واضح في زيادة مستوى التحصيل الدراسي للطلاب وفقا لما ذكرته العديد من الدراسات في مجموعة، ناقش بعض مفاهيم النظرية البنائية (ملحق 2- 2) مع اشتقاق بعض التطبيقات التربوية لتلك المفاهيم.

ملحق(2- 2)

مقدمة في برنامج التقويم المعتمد على الأداء، ص9- 11.

نشاط(2- 3)

افترض انك في مجموعة تدريبية تقوم بتدريب معلمي العلوم حديثي التخرج على استخدام طرق تدريس تركز على استخدام التلاميذ لعمليات عقلية عليا كمرحلة أولى في البرنامج التدريبي سوف تقوم بتدريبهم على استخدام أسلوب حل المشكلات وأسلوب الاستقصاء المطلوب منك في هذا البرنامج:

- **أن تقوم بتعريف أسلوبي حل المشكلات والاستكشاف للمتدربين.**
- **أن تميز بين الأسلوبين.**
- **أن تقترح إستراتجية لكل منهما يمكن أن يستخدمها المعلم في الصف.**

ملحق(2-3)

مقدمة في برنامج التقويم المعتمد على الأداء.

نشاط (2- 4)

التقويم يمكن استخدامه لأغراض نهائية كانتقال التلميذ من صف لآخر أو لأغراض تكوينية(بنائية) السؤال إذا كان استخدام التقويم للأغراض النهائية وما يترتب عليها من نجاح التلميذ أو رسوبه معروفه للجميع فماذا يقصد بالأغراض التكوينية؟ وما الفائدة منها؟

ملحق (2- 4)

مقدمة في برنامج التقويم المعتمد على الأداء.

ورشة رقم (3)

متطلبات تطبيق التقويم المعتمد على الأداء

أهداف الورشة

يتوقع من المتدرب بعد حضور هذه الورشة أن:

1 -يكون قادرا على تصميم أو انتقاء مهام تقويمية تعتمد على الأداء بناء على معايير محددة.

2 -يقوم بتكييف أنشطة تقويمية للوحدة التاسعة لتلائم تلاميذه .

3 -يطبق بشكل فاعل الأنشطة القائمة على التقويم البديل في الصف.

4 -يعد الأنشطة الإضافية المناسبة لكل من التلاميذ ذوي التحصيل المرتفع والمنخفض

جدول الورشة الزمني

النشاط رقم	الفعالية	الزمن بالدقائق
(1)	الإعداد والتخطيط لتطبيق نشاط الكهرباء رقم (1)	60
(2)	الإعداد والتخطيط لتطبيق نشاط الكهرباء رقم (2)	60
(3)	الإعداد والتخطيط لتطبيق نشاط الكهرباء رقم (3)	60
(4)	الإعداد والتخطيط لتطبيق نشاط الكهرباء رقم (4)	50

نشاط (3- 1)

أ راجع نشاط الكهرباء رقم (1) بناء على :

1 - معايير تصميم أو اختيار أنشطة تستند على التقويم الأدائي.

2 - مدى مناسبة النشاط للصف الذي تدرسه من حيث الوقت، المكان وتوفر الأدوات.

ب اعد نشاط إضافي وواجب منزلي كامتداد للنشاط الأساسي لكل من ذوي التحصيل المرتفع والمتدني.

جـ صمم نموذج لملاحظة التلاميذ أثناء عملهم في النشاط داخل الصف.

ملحق(3- 1)

وحدة الكهرباء، نشاط رقم (1).

نشاط(3- 2)

- أ راجع نشاط الكهرباء رقم(2) بناء على :

1 -معايير تصميم أو اختيار أنشطة تستند على التقويم الأدائي.

2 -مدى مناسبة النشاط للصف الذي تدرسه من حيث الوقت، المكان وتوفر الأدوات.

-ب قم بإعداد نشاط إضافي وواجب منزلي كامتداد للنشاط الأساسي لكل من ذوي التحصيل المرتفع والمتدني.

جـ قم بإعداد طريقة لعمل التلاميذ في مجموعات.

ملحق(3- 2)

وحدة الكهرباء، نشاط رقم (2).

نشاط (3- 3)

- أ راجع نشاط الكهرباء رقم(3) بناء على:

1. معايير تصميم أو اختيار أنشطة تستند على التقويم الأدائي.

2. مدى مناسبة النشاط للصف الذي تدرسه من حيث الوقت، المكان وتوفر الأدوات.

ب-اعد نشاط إضافي وواجب منزلي كامتداد للنشاط الأساسي لكل من ذوي التحصيل المرتفع والمتدني.

جـ اعد إستراتيجية لتصحيح أنشطة التلاميذ.

ملحق(3- 3)

وحدة الكهرباء، نشاط رقم (3).

نشاط (3- 4)

أ- راجع نشاط الكهرباء رقم(4) بناء على :

1. معايير تصميم أو اختيار أنشطة تستند على التقويم الأدائي.

2. مدى مناسبة النشاط للصف الذي تدرسه من حيث الوقت، المكان وتوفر الأدوات.

ب-اعد نشاط إضافي وواجب منزلي كامتداد للنشاط الأساسي لكل من ذوي التحصيل المرتفع والمتدني.

ملحق(3- 4)

وحدة الكهرباء، نشاط رقم(4)

ورشة رقم (4)

تكملة

جدول الورشة الزمني

النشاط رقم	الفعالية	الزمن بالدقائق
(1)	الإعداد والتخطيط لتطبيق نشاط الكهرباء رقم (5)	60
(2)	الإعداد والتخطيط لتطبيق نشاط الكهرباء رقم (6)	60
(3)	الإعداد والتخطيط لتطبيق مهمة التقويم رقم (1)	60
(4)	الإعداد والتخطيط لتطبيق مهمة التقويم رقم (2)	50

نشاط(4- 1)

أ- راجع نشاط الكهرباء رقم(5) بناء على :

1. معايير تصميم أو اختيار أنشطة تستند على التقويم الأدائي.
2. مدى مناسبة النشاط للصف الذي تدرسه من حيث الوقت، المكان وتوفر الأدوات.

ب-اعد نشاط إضافي وواجب منزلي كامتداد للنشاط الأساسي لكل من ذوي التحصيل المرتفع والمتدني.

جـ اعد طريقة لتسجيل نتائج التلاميذ في نهاية كل أسبوع.

ملحق (4- 1)

وحدة الكهرباء، نشاط رقم (5)

نشاط(4- 2)

أ- راجع نشاط الكهرباء رقم(6) بناء على :

1 معايير تصميم أو اختيار أنشطة تستند على التقويم الأدائي.

2 مدى مناسبة النشاط للصف الذي تدرسه من حيث الوقت، المكان وتوفر الأدوات.

ب-اعد نشاط إضافي وواجب منزلي كامتداد للنشاط الأساسي لكل من ذوي التحصيل المرتفع والمتدني.

ملحق (4- 2)

وحدة الكهرباء، نشاط رقم (6)

نشاط(4- 3)

مهام التقويم تشبه إلى حد كبير اختبارات نهاية الوحدة، إلا إنها تتميز عنها بفوائدها التعليمية حيث تعتبر امتدادا لتدريس الوحدة فيما تستخدم لأغراض التقويم ناقش ضمن مجموعتك مهمة التقويم رقم (1) لبحث كيفية تطبيقها وتجهيز الأدوات اللازمة.

ملحق(4- 3)

مهمة الكهرباء رقم (1)

نشاط (4- 4)

راجع مهمة التقويم رقم (2)

ملحق(4- 4)

مهمة الكهرباء رقم (2)

ورشة تدريبية رقم (5)
إعداد أساليب مختلفة للتقويم

أهداف الورشة

يتوقع من المتدرب بعد حضور هذه الورشة أن:

1 - يضع خطة لاستخدام سجل التقويم.
2 - يصمم طريقة لمتابعة مشاريع التلاميذ وتصحيحها.
3 - يقترح أسلوب عملي لملاحظة ورصد أداء التلاميذ
4 - يقترح بعض نماذج التقويم الذاتي للتلاميذ وأسلوب متابعتها.

جدول الورشة الزمني

النشاط رقم	الفعالية	الزمن بالدقائق
(1)	الإعداد والتخطيط لتطبيق محفظة التقويم	60
(2)	الإعداد والتخطيط لتطبيق مشاريع	60
(3)	اقتراح أسلوب لملاحظة التلاميذ	60
(4)	تصميم نموذج للتقويم الذاتي وتدريب التلاميذ على استخدامه	50

نشاط (5- 1)

محفظة التقويم ليس مجرد ملف توضع فيه بعض أعمال التلميذ، بل عبارة عن أداة تقويم مهمة يمكن أن تستخدم لعدة أغراض تربوية.ناقش في إطار مجموعتك فكرة محفظة التقويم لتطوير طريقة يمكن من خلالها تفعيل هذه الأداة في مدارسنا بحيث تتضمن:

1 - نوعية الأعمال التي ينبغي على الطالب إدراجها في سجل التقويم.
2 - المكان الذي يجب أن يحفظ فيه السجلات ومتى وكيف يرجع إليه الطالب.
3 - كيفية تصحيح سجل التقويم.

ملحق (5- 1)

مقدمة في التقويم المعتمد على الأداء، ص29- 30.

نشاط (5- 2)

المشروع عبارة عن عمل إبداعي يتحرر فيه التلميذ من القيود الزمانية والمكانية للبيئة المدرسية مما يمكنه من استغلال قدراته وممارسة مهارات علمية ذات مردود ايجابي لكلا الجانبين التحصيلي والشخصي للطالب في مجموعة ناقش الثلاث مشاريع التي تم إعدادها لوحدة الكهرباء من حيث:

1 - كيفية متابعة التلاميذ أثناء عمل التلميذ على أي منها.
2 - تصميم (قواعد الأداء) لتصحيح كل منها.
3 - مدى إمكانية التلاميذ لتقديم أعمالهم.
4 - اقتراح مشاريع أخرى لنفس الوحدة.

ملحق (5- 2)

مقدمة في التقويم المعتمد على الأداء، ص

نشاط (5- 3)

جانب كبير من سلوك التلاميذ لا يمكن تقويمه من خلال أداءهم التحريري داخل الفصل مما يتعين ملاحظته مباشرة باستخدام احد أساليب الملاحظة في هذا النشاط قم بالاشتراك مع أفراد مجموعتك بإعداد أسلوب لملاحظة التلاميذ داخل الفصل بحيث يحتوي على :

1 -نموذج لرصد نتائج الملاحظة.
2 -أسلوب الملاحظة.
3 -كيفية دمج نتائج الملاحظة مع بقية أدوات التقويم.

ملحق (5- 3)

مقدمة في التقويم المعتمد على الأداء ص22- 23.

نشاط (5- 4)

يعد التقويم الذاتي احد العناصر الأساسية للتقويم البديل التي يتوجب على المعلم أخذه بعين الاعتبار وحث التلاميذ على استخدامه في مجموعة، راجع نماذج التقويم الذاتي في ملحق(5- 4) ثم اجب على هذه الأسئلة .

1 أي من هذه النماذج مناسبا لاستخدامه مع تلاميذك؟ ولماذا؟
2 ما هي الطريقة التي تقترحها لتدريب التلاميذ وحثهم على استخدامه؟
3 رتبها لتدريب التلاميذ على استخدامها مبتدئا بالأسهل.

ملحق (5- 4)

مقدمة في التقويم المعتمد على الأداء.

ورشة تدريبية رقم (6)
إعداد أنشطة ومهام لوحدة المغناطيس

أهداف الورشة

يتوقع من المتدرب بعد حضور هذه الورشة أن:

1 يكون قادرا على تصميم أو انتقاء مهام تقويمية لوحدة المغناطيس تعتمد على الأداء بناء على معايير محددة.

2 -يقوم بتكييف أنشطة تقويمية لتلائم تلاميذه على هذه الوحدة.

3 -يطبق بشكل فاعل الأنشطة القائمة على التقويم البديل في الصف.

4 -يقوم بإعداد أنشطة الإضافية المناسبة لكل من التلاميذ ذوي التحصيل المرتفع والمنخفض.

جدول الورشة الزمني

النشاط رقم	الفعالية	الزمن بالدقائق
(1)	الإعداد والتخطيط لتطبيق نشاط المغناطيس رقم(2،1)	60
(2)	الإعداد والتخطيط لتطبيق نشاط المغناطيس رقم(4،3)	60
(3)	الإعداد والتخطيط لتطبيق نشاط المغناطيس رقم(6،5)	60
(4)	تصميم مشاريع لوحدة المغناطيس	50

راجع نشاط المغناطيس رقم(1- 6) بناء على :

أ-

1. معايير تصميم أو اختيار أنشطة تستند على التقويم الأدائي.
2. مدى مناسبة النشاط للصف الذي تدرسه من حيث الوقت، المكان وتوفر الأدوات.

ب-اعد نشاط إضافي وواجب منزلي كامتداد للنشاط الأساسي لكل من ذوي التحصيل المرتفع والمتدني.

- جـ اقتراح مشاريع لهذه الوحدة .

ورشة تدريبية رقم (7)

إعداد أنشطة ومهام لوحدة الصوت

أهداف الورشة

يتوقع من المتدرب بعد حضور هذه الورشة أن:

1 أن يتعرف على أهداف عمل المجموعات التعاونية

2 يكون قادرا على تصميم استراتيجيات متنوعة للتعلم التعاوني

جدول الورشة الزمني

النشاط رقم	الفعالية	الزمن بالدقائق
(1)	عمل المجموعات	60
(2)	التعلم التعاونى	60
(3)	أساليب التعلم التعاوني	60

نشاط رقم (7- 1)

عمل المجموعات يتشكل من قيام طالبين أو اكثر للعمل جميعا لتحقيق هدف أو أهداف محدده ناقش مع أعضاء مجموعتك أهم خصائص العمل الجماعي.

ملحق (7- 1)

Killen (2003), Effective Teaching Strategies, third edition, Social Science Press, Australia.

نشاط رقم (7- 2)

التعلم التعاوني لا يعنى تعلم كيفية التعاون بقدر ما يعتمد على التعاون ليتم التعلم

(Wong & wong, 1998 cited in Killen,2003, p. 147).

اشرح مع أفراد مجموعتك هذه العبارة

ملحق (7- 2)

Killen (2003), Effective Teaching Strategies, third edition, Social Science Press, Australia.

نشاط رقم (7- 3)

"يعتبر التعلم التعاوني طريقة فعاله لاكتساب الطالب مدى واسع من المخرجات العلمية والاجتماعية التى تتضمن تعزيز التحصيل الدراسي، تحسين تقدير الطالب لذاته ، تكوين علاقة ايجابية مع الآخرين ، تقوية مهارات إدارة الوقت، و تكوين اتجاهات ايجابية نحو العلوم

(Killen, 2003, p. 151).

ملحق (7- 3)

Killen (2003), Effective Teaching Strategies, third edition, Social Science Press, Australia.

ورشة تدريبية رقم (8)

تقدير صعوبات تطبيق البرنامج

جدول الورشة الزمني

أهداف الورشة

يتوقع من المتدرب بعد حضور هذه الورشة أن:

1 يقترح بعض الطرق لإعطاء الطلبة تغذية راجعه

2 تقويم مشروع الدراسة وتصميم خطه لتطبيقها

جدول الورشة الزمني

النشاط رقم	الفعالية	الزمن بالدقائق
(1)	الأساليب التعزيزية لتحفيز التلميذ على تحسين أداءه	60
(2)	إستراتيجية التقويم المعتمد على الأداء	60
(3)	دليل استخدام برنامج التقويم الأدائي	60
(4)	تقديم البرنامج للتلاميذ	50

نشاط رقم (8- 1)

التغذية الراجعة التي يزود بها المعلم تلاميذه بعد تصحيح أو مراجعة أعمالهم كعبارة"تحتاج إلى العمل"بجد ، "حسن خطك" أو كان عملك في الجزء الأول واضحا وكتب بشكل جيد ، ولكن الجزء الأخير يحتاج إلى توضيح عن طريق عرض بعض الأمثلة أو تضمينه بعض الصور مثل هذه العبارات قد يكون لها اثر ايجابي أو سلبي بناء على الطريقة التي اتبعها المعلم ناقش مع أفراد مجموعتك كيف يمكن أن تؤثر طريقة التغذية الراجعة بشكل سلبي أو ايجابي على أداء التلميذ وما هي أفضل الطرق التي ينبغي على المعلم إتباعها ليستفيد التلميذ إلى أقصى قدر من مراجعة المعلم لأعماله؟ ومتى ينبغي منح التلميذ مكافأة تقديرية؟

ملحق رقم (8- 1)

1- Chappuis, S., & Stiggins, R. J. (2002). Classroom Assessment for Learning Classroom Assessment for Learning. *Educational Leadership* (Vol. 60, pp. 40): Association for Supervision & Curriculum Development.

2- Black, P., & William, D. (1998b). Inside the Black Box: Raising Standards Through Classroom Assessment. *Phi Delta Kappa, 80* (2), 139-149.

نشاط رقم (8- 2)

وفقا لإستراتيجية برنامج التقويم المعتمد على الأداء (انظر ملحق 8- 2) صمم خطة لتدريس أي من الموضوعات التي تختارها من الوحدات 10،9 أو 11.

ملحق (8- 2)

مقدمة في برنامج التقويم المعتمد على الأداء، ص 15- 31.

نشاط (8- 3)

ناقش مع مجموعتك الآتي:

1. الجوانب التي ترى أنها تحتاج إلى مزيد من الإيضاح ليتسنى لك تطبيق البرنامج بنجاح.
2. أهم الصعوبات التى تتوقع أن تواجهها أثناء تطبيق هذا البرنامج مع اقتراح بعض الحلول للتغلب عليها.

نشاط (8- 4)

يتطلب تطبيق البرنامج في بداية الأمر تهيئة وتوعية تلاميذ الصف السادس على كيفية استخدامه وما هو الدور المطلوب منهم القيام به اقترح بالتعاون مع أفراد مجموعتك طريقة يمكن من خلالها تقديم البرنامج للتلاميذ بشكل ناجح

برنامج التقويم المعتمد على الأداء

مقدمة في التقويم المعتمدة على الأداء

إعداد

عبدالله بن صالح السعدوي

إشراف

البروفسور موريين رايان

الدكتور انتونى وات

مقدمة

أصبح الحديث عن تطوير أساليب التعليم والتدريس في التعليم العام من أكثر الأمور وضوحا وتكرارا سواء في وسائل الإعلام المختلفة أو في أحاديث أولياء الأمور التي لا تخلو عادة من النقد والتذمر من الأساليب الحالية في التعليم و التي تركز بشك ل أساسي على الحفظ والتلقين يقول احد الكتاب" نحن نريد تعليماً يصنع عقولاً قادرة على التفكير على الاستنتاج وعلى التحليل وليست مجرد أجهزة حفظ .؟؟ نريد طالباً لا يجد صعوبة في قراءة ما بين أسطر السؤال، طالباً ينظر للعلم من باب العقل لا من باب الصم والحفظ فقط باعتبار أن الحفظ أيضا عملية عقلية"[1] ويقول أخر" فمن حيث أهداف المناهج فهي غالباً ما تهتم بتنمية الجزء المتعلق بالحفظ والاستظهار، على حساب المهارات العقلية العليا، فتغفل بذلك عن تحصيل الطالب للمهارات العملية والمهنية، أو تعويده على البحث والاستقصاء الذاتي"[2] هذا النقد ليس مقتصرا على الكتاب أو أولياء الأمور الذين قد يتهمون بالمبالغة وعدم الوقوف على حقيقة الأمور داخل أسوار المدرسة بل برز ايضا من بين مقاعد الدراسة ، يقول احد الطلاب متذمرا من أسلوب التعليم الحالي "أن الطالب يتلقى كماً من المعلومات يتلقاه لا لأجل الانتفاع بها في حياة ونفع أمته بها، وإنما يتلقاه لأجل تجاوز الاختبار بها فإذا ولى الاختبار نبذها وراء ظهره وكأنها لم تمر عليه مطلقاً"

هذه الانتقادات لم ينكرها المتخصصون ، بل اقروا بها واعترفوا بعجز الأساليب التعليمية القائمة على حشو العقول عن الرقي بالعملية التعليمية يقول أحد المتخصصين في التقويم التربوي" الاختبارات الحالية تجعل الطالب وعاء للمعلومات ينساها بمجرد نجاحه في الاختبار" [3]

ولكن ما الحل؟ كيف يمكن دفع التلاميذ إلى استخدام كل ما وهبهم الله من قدرات عقلية بدلا من اختزالها في قدرة واحدة تقوم على الحفظ والاسترجاع؟ ما طرائق التدريس والتقويم التي ينبغي على المعلمين استخدامها لتحفيز التلاميذ على استخدام كل قدراتهم وطاقاتهم ليتفاعلوا بالعمل والنقاش والمشاركة في العملية التعليمية باعتبار أنها تعنيهم بالدرجة الأولى؟ فهي لهم ومن اجلهم وليس مفروضة عليهم من المعلم الذي يلزمهم بحفظ الكتاب المقرر دون مراعاة للفروق الفردية بين التلاميذ ولاتجاهاتهم نحو الموضوعات المقرر ة أو المدرسة بشكل عام بأي صيغة يجب أن يصاغ المقرر للتلاميذ؟ وكيف يجب أن يقوم؟

إن معظم النقاد الذين لا تكاد تخلو صحيفة أو مجلة أو وسيلة من وسائل الاتصال من اعتراضاتهم على طرائق التعليم الحالية، لم يقدوا أسلوبا أو طريقة للإجابة على هذه التساؤلات وربما يكون ذلك أمرا متوقعا فتطوير أساليب التدريس و طرائق التقويم ليست من القضايا التي يمكن تناولها على صفحات الجرائد أو عبر البرامج الإذاعية أو التلفزيونية ولا من خلال المهرجانات الاحتفالية بل هي طريق شاق يسلكه المخلصون من التربويين وعلى رأسهم المعلمون لذلك فان هذا البرنامج بما يشمل من أجزاء ثلاثة يحاول أن يقدم إجابة على بعض التساؤلات التي طرحت سابقا.

إن الباحث وهو يستعرض هذا البرنامج التربوي الذي يهدف إلى تطوير أداء المعلم والتلميذ على حد سواء، لا يدعى بحال بأن البرنامج قائم على إبداعاته الشخصية بل اعتمد في بنائه على العديد من عمليات الإصلاح التربوي التي شهدتها العديد من الدول والتى أنتجت كم هائل من المعارف والخبرات التربوية ، حيث أثبتت الكثير منها فاعليتها في تقدم مستوى التحصيل الدراسي للتلاميذ لذلك إذا كانت الحكمة تقتضي أن نبدأ من حيث وقف الآخرون ، فان في تجارب الأمم السابقة خير بداية وهذا ما قام به الباحث حيث انتقي

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[1] مقال لهيا المنيع بعنوان" من غير المناهج" في جريدة الرياض بتاريخ 2003/9/29

[2] مقال لثربا الشهري بعنوان" أي تربية لأي تنمية.. وأي تنمية لأي نهضة!" نشر بجريدة الشرق الأوسط بتاريخ2004/8/11

[3] تقرير صحفي بعنوان النظام الحالي لا يحقق الإبداع والتميز للطالب ،أكاديميون :التقويم المستمر محاولة للخروج من مأزق الاختبارات والحشو والغش والتسرب المدرسي. جريدة الوطن، العدد1436 في 2004/9/4 م

من تلك الخبرات والتجارب ما يعتقد انه يتوافق مع معتقداتنا الدينية وقيمنا الاجتماعية و عمل على تكييفها لتلبي ما نسعى إلى تحقيقه من أهداف تربوية.

إن معظم حركات التطوير التربوي تشير بشكل أساسي إلى أن التلميذ يصبح فاعلا إذا أعطى الفرصة ليشارك في العملية التعليمة التي هو محورها ، لذلك تدعو المعلمين إلى تشجيع التلاميذ على المشاركة بشكل واعي في عمليات تعلمهم وان يصبحوا أكثر اعتمادا على الذات لتقويم مستوى أدائهم Akerson, Morrison, & Mcduffie,2002) إن التعليم الفعال كما ترى تلك الحركات التطويرية يتطلب أكثر من عمليتي الحفظ والاسترجاع ، انه يتطلب القيام بعمليات عقلية عليا كإيجاد حل لمشكلة علمية مثلا ووصف الخطوات التي اتخذت لحلها ، وهذا النوع من التعلم يتطلب التقويم المعتمد على الأداء

إضافة إلى ذلك فان هذا البرنامج يقع ضمن سلسلة من المشاريع التطويرية التى تقوم بها الإدارة العامة للقياس والتقويم بهدف الانتقال من الأساليب التقليدية في التقويم وما يرتبط بها من ممارسات تربوية قديمة إلى استخدام أساليب بديله تفرضها سنة التغيير واللحاق بركب من سبقنا ليس لتقليل الفجوة بيننا وبين المجتمعات الأكثر تطورا فحسب ولكن للدخول معها في تنافس علمي يؤهلنا بمشيئة الله لتبؤ مركزا مشرفا بين الأمم، وما مشاركة المملكة في الاختبار الدولي للعلوم والرياضيات (TIMSS,2003) الذي يضم أكثر من خمسين دولة إلا بداية شجاعة للدخول في ذلك المعترك العلمي الشريف

ومهما يكن من أمر ، فان نجاح هذا البرنامج وغيره من البرامج التربوية يعتمد بعد الله سبحانه وتعالى على مدى قناعة وإقبال المعلم الذي يعد حجر الزاوية في أي تغيير يراد له النجاح فان لم يكن لدى المعلم القناعة التامة بفائدة هذا البرنامج و الإتقان الضروري للمهارات اللازمة لتطبيقه فلن يعدوا أكثر من إضافة نزين بها مكتباتنا أو ننمق بها أحاديثنا أوفي أفضل الأحوال نستشهد بها في مقالاتنا التربوية

هذا الجزء من البرنامج سيقدم بشكل مختصر بعض المفاهيم التي يقوم عليها التقويم المعتمد على الأداء وطرائق تصميم وسائله إضافة إلى الاستراتيجيات المختلفة التي يمكن استخدامها لتطبيقه في الصف الدراسي كما يتضمن هذا الجزء دليلا لتطبيق البرنامج على تلاميذ الصف السادس الابتدائي في مادة العلوم.

1. **أهداف البرنامج**

يهدف هذا البرنامج إلى تجويد تعلم التلاميذ وتطوير طرائق التدريس من خلال القيام بالأمور التالية:

أولا بالنسبة للتلميذ، يهدف البرنامج إلى تحفيز التلميذ على:

القيام بعمليات عقلية عليا كالتطبيق والتحليل والتقويم.

1. استخدام مهارات تطبيقية في العلوم كالقدرة على القيام بتجربة علمية أو تكوين منتج .
2. استخدام عدة استراتيجيات للتعلم كأسلوب حل المشكلات و أسلوب الاستقصاء.
3. تنمية مهارات الاتصال التحريري كرسم نموذج أو شكل بياني و اللفظي كتقديم عرض أو مناقشة مشروع
4. ربط المحتوى المعرفي لمادة العلوم بواقع الحياة ذات الصلة ويتضمن ذلك ابتكار طرائق أو أساليب جديدة لحل مشكلة علمية أو إنتاج عمل علمي.
5. تنمية مهارات التقويم الذاتي .
6. إتباع منهج البحث العلمي لدراسة الظواهر العلمية.
7. تكوين اتجاهات وقيم ايجابية نحو مادة العلوم.

ثانيا بالنسبة للمعلم ، يهدف البرنامج إلى مساعدة المعلم على :

1. تعلم مهارات التقويم المعتمد على الأداء(التقويم البديل) وتطبيقه في الصف السادس.
2. تطبيق بعض الأساليب الحديثة لتدريس مادة العلوم.
3. دمج عناصر العملية التعليمية التدريس والتقويم والمنهج بشكل تفاعلي وتوجيههم للرفع من مهارة التلاميذ.

متطلبات تطبيق البرنامج:

لتطبيق البرنامج بشكل فعال، يجب مراعاة العوامل التالية :

- دمج العمليات التعليمية الثلاث التدريس والتقويم والمنهج بشكل تفاعلي يخدم كل منها الآخر.
- تطبيق أساليب تعليمية وتدريسية تعطى التلميذ الدور الأساسي في التعلم وتشجعه عليه.
- توفير المادة العلمية المناسبة .

ولتحقيق الأهداف السابقة ، تم تقسيم البرنامج إلى قسمين رئيسين:

القسم الأول البرنامج المهني للتقويم المعتمد على الأداء ويهدف إلى تزويد معلمي العلوم بالمعارف والمهارات الأساسية لاستخدام الاختبارات المعتمدة على الأداء ويشمل هذا القسم على:

مقدمة في التقويم المعتمد على الأداء ويتضمن هذا الجزء بعض المفاهيم الأساسية للتقويم الأدائي إضافة إلى وصف كامل لمكوناته وكيفية تصميم أدواته.

ورش عمل في تطبيق التقويم المعتمد على الأداء

القسم الثاني بناء وحدات عمل تقوم على استخدام التقويم المعتمد على الأداء ويهدف هذا القسم إلى تصميم وبناء وحدات في مادة العلوم للصف السادس تفي بمتطلبات التقويم المعتمد على الأداء.وقد تم إعداد ثلاث وحدات لمادة العلوم للصف السادس الابتدائي.

وفيما يلي عرض تفصيلي للقسم الأول(أ) من البرنامج -

2-نحو تقويم صفي بديل

في السنوات الأخيرة أصبح التركيز بشكل ملحوظ على تدريس كل من المفاهيم والعمليات العلمية لمادة العلوم باعتبارهما جزأين يكمل كل منهما الآخر .(NCSESA,1993) وللتوافق مع هذا الاتجاه ظهرت الحاجة إلى استحداث أساليب جديدة للتقويم يمكن أن تساعد على قياس مهارات عقلية وتطبيقية كمهارات التفكير والتواصل وحل المشكلات إضافة إلى فهم الموضوع العلمي المقصود مما مهد الطريق لظهور التقويم المعتمد على الأداء كعامل أساسي لتجويد التعليم و قياس مخرجاته

وتمشيا مع هذا الاتجاه أصبح الهدف الأساسي للتقويم وبشكل خاص في مادة العلوم ، تزويد المعلم والتلاميذ على حد سواء بتغذية راجعة يمكن أن يستفيد منها كل منهم في تطوير أدائه (Akerson et al. ,2002; Guy & Wilcox, 2000). وبذلك أصبح التقويم ليس مجرد اختبار في نهاية الحصة أو الوحدة الدراسية لمعرفة كيف حفظ الطالب ما تم تلقينه أو قرأه في كتابه المدرسي بل دمج بشكل تكاملي مع التدريس وأصبح ملازما ومسايرا له ، لذلك ظهرت الحاجة للتقويم المعتمد على الأداء باعتباره الأسلوب الأمثل للتقويم الصفي، حيث يتيح تقويم العلميات والإجراءات التي يقوم بها التلميذ إضافة إلى توفير تغذية راجعة له تساعده في التعرف على نواحي القوة والضعف في أدائه.

يعرف التقويم المعتمد على الأداء بأنّه اختبار يتطلب من التلميذ تقديم إجابة أو ابتكار منتج يبين مستواه المعرفي والمهاري (The Office of Technology Assessment of the U.S. Congress, as cited in Feuer, 1995,pp 202-203) وسوف أستخدم مسمى الاختبارات المعتمدة على الأداء والاختبارات الأدائية في سياق هذه المقدمة كمترادفين لتشير للمعنى الموضح في التعريف.

وإلى جانب هذا التعريف حدد بعض التربويين عدد من الخصائص لهذا النوع من التقويم ، منها على سبيل المثال:

- يقيس العمليات الإجرائية والمعرفية التي يقوم بها التلميذ بالإضافة إلى النتائج النهائية كما يقدم مدى واسع من المخرجات التعليمية (Danielson, 1997; Shepard, Flexer, Hiebert, Marion, Mayfield, & Weston, 1996).
- يسمح بطرح موقف حقيقي أو طبيعي للتقويم ذا قيمة تربوية ، مشابه لتلك المواقف التي يواجهها التلميذ في واقع حياته (Stenmark, 1991).
- يساعد على الاحتفاظ بالجوانب المعقدة والمتداخلة للعمليات المعرفية والمهارية (Shepard, et al., 1996; Shymansky, et al., 1997) بمعنى أن الموقف التعليمي يتضمن القيام بالعديد من المهارات والعمليات العقلية كالتفكير والإبداع وحل المشكلات والاعتماد على النفس والتعاون مع الآخرين وإعادة ترتيب الأفكار وما إلى ذلك من عمليات متداخلة يصعب على غير الاختبارات الأدائية قياسها (الدوسري،2000).
- يقيس عمليات عقلية عليا ودرجات عميقة من الفهم (Firestone, Mayrowtz, & Fairman, 1998) .
- يساير التدريس ويتكامل معه (Stenmark, 1991)
- يستخدم مداخل تقويمية مرجعية المحك تستند على أهمية المخرجات التعليمية بدلا من معيارية المحك (Stenmark, 1991) .

3- متطلبات تطبيق التقويم المعتمد على الأداء

يعتقد Howell, Brocato, Patterson, & Bridges (1999) أن تطبيق الاختبارات الأدائية في الصف الدراسي يتطلب تغييرا جذريا في الممارسات التقليدية للتدريس ، فأساليب التقويم سوف تتكامل مع طرائق

التدريس وبالتالي تصبح الحدود الفاصلة بين التقويم والتدريس داخل الصف اقل وضوحا مما يعطي التلميذ فرصة لأن يكون أكثر نشاطا وتزداد دافعيته للتعلم
لذلك لا يكفى المعلم تغيير طرائق التدريس التي يتبعها بل أيضا تغيير نظرته وطريقة تفكيره نحو كل من التدريس والتعليم على حد سواء في الواقع لا يزال العديد منا كمعلمين يعتقد بان على التلميذ داخل الصف الإنصات للمعلم كمصدر رئيس للمعرفة واستحضار ما يتم تلقينه أو حفظه من الكتاب المدرسي وما عدا ذلك من نشاط حركي أو عقلي يقوم به التلميذ يعتبر سلوكا غير مرغوب فيه يعرقل التحصيل الدراسي للتلميذ وزملائه هذا الاعتقاد ربما نشأ أساسا من القول الشائع عقل التلميذ كالوعاء الفارغ يتطلب من المعلم فقط ملأه بالمعارف المفيدة"(Hinrichsen & Jarrett,1999) إضافة إلى ذلك يعتقد البعض بأن التلميذ ليس لديه القدرة على التعلم الذاتي، فهو في حاجة دائمة إلى التعليم الموجه من قبل معلمه.
تلك التصورات القديمة لم يعد لها مستند علمي في التربية الحديثة، بل على العكس من ذلك نتائج العديد من الأبحاث والدراسات العلمية في علم النفس التعليمي وعلم نفس النمو دحضتها وأثبتت خطأها مما مهد السبيل لظهور طرائق أخرى أكدت فاعليتها في التعلم، فأصبحت تلك التصورات من العوامل التي يعتقد بأنها مسئوله بشكل كبير عن تدني مستوى التحصيل الدراسي للتلاميذ ولهذا ركزت معظم الاتجاهات التربوية الحديثة على المدخل البنائي في التعلم Constructivist –وهو من أكثر المداخل التعليمية تلاؤما مع التقويم الأدائي ونتيجة لذلك ظهرت العديد من التطبيقات التربوية التي أثرت بشكل فاعل في طرائق تدريس العلوم وتعلمه في العقدين الماضيين (Aubusson &Watson, 2003;Kim,1999) .
أنصار النظرية البنائية يعتقدون أن الفرد يفهم المواقف الخارجية من خلال منظوره الخاص المبنى على تجاربه الخاصة في الحياة (Aubuon &Watson, 2003) لذلك يحضر التلميذ معه لحجرة الدراسة خبراته السابقة التي تقاوم التعلم بأساليب التدريس التقليدية، لأنها ببساطه اعتمدت بشكل أساسي على تجارب حقيقية عايشها التلميذ وأصبحت توجه سلوكه وتؤثر على درجة تقبله للمفاهيم التي يتلقاها بأسلوب تلقيني في المدرسة (Aubuon &Watson, 2003) ، وهذا ربما يفسر لماذا ينسى التلاميذ عادة وبشكل سريع ما تعلموه ، وطبقا لهذا المدخل التعليمي فان المعرفة ليست مجرد شيء يوجد في مكان ما ليتم التقاطه ، بل هي عمليات مستمرة من النقد والإبداع (Chang,n.d.) .
لذلك بدأ المعلمون يدركون بأن التعلم يتم بشكل أفضل من خلال التجارب الشخصية ومن خلال ربط المعارف الجديدة بالخبرات السابقة للتلميذ وهذا ما يؤكده المربون ،فالتلاميذ يتعلمون بشكل جيد عندما يعملون بأنفسهم بدلا من الملاحظة النظرية لنموذج سابق ، لأنهم بذلك يبنون معارفهم بغض النظر عن براعة المعلم في الشرح أو وضوح الكتاب المدرسي (AAAS,1990; Hinrichsen& Jarrett,1999) .
تمشيا مع هذا الاتجاه بدأ معلمو العلوم يتحولون من استخدام طرائق التدريس الموجهة مباشرة من المعلم للتلميذ إلى إشراك التلاميذ في عمليات تعلمهم من خلال دفعهم إلى القيام ببعض الأنشطة التعليمية داخل الصف كعمل تجارب علمية ، وحل مشكلة معينة أو مناقشة موضوع معين بهدف تحقيق أهداف تعليمية محددة أثناء ذلك يمكن للمعلم تقويم أداء تلاميذه من خلال متابعة أداءهم والتعرف على الصعوبات التي يواجهونها والتقدم الذي أحرزوه والتوصل من ذلك كله لمدى نجاح خطته التدريسية، ومدى الحاجة إلى تعديلها أو تطويرها وبهذا تتضح عملية الربط بين التدريس والتقويم التي يلخصها هيرمان وآخرون Herman, Aschbacher, and Winters (1992) في الجدول التالي:

ربط التدريس والتقويم
تطبيقات من نظرية التعلم المعرفي
من مبادئ نظرية التعلم المعرفي المعرفة بنائية،والتعلم هو عملية تكوين معنى ذاتي تنشأ عن عمليات الربط

بين المعلومات الجديدة والمعارف السابقة.

تطبيقات هذا المبدأ في عمليتي التدريس والتقويم:

ينبغي على المعلم أن

يشجع التلاميذ على مناقشة الأفكار الجديدة.

يحفز التلاميذ على استخدام أساليب التفكير المتشعب (divergent thinking) أي التفكير في أكثر من حل للمشكلة الواحدة أو إيجاد إجابات متنوعة وليس فقط الاكتفاء بحل واحد صحيح.

يدرب التلاميذ على استخدام أنماط متعددة من أساليب الشرح أو التعبير مثل لعب الأدوار، التقليد، الحوار، الشرح للآخرين.

يركز على مهارات التفكير النقدي كالتحليل، المقارنة، التعميم، التوقع وفرض الفروض.

بربط الأفكار الجديدة بالخبرات الشخصية والمعارف السابقة للتلاميذ.

بطبق المعارف على مواقف جديدة

من مبادئ نظرية التعلم المعرفي الناس من كل الأعمار/القدرات يمكن أن يفكروا وأن يحلوا مشاكل مختلفة فالتعلم ليس بالضرورة اتجاه خطى لأصحاب المهارات المتميزة.

تطبيقات هذا المبدأ في عمليتي التدريس والتقويم:

ينبغي على المعلم أن:

يشجع كل التلاميذ على استخدام أسلوب حل المشكلات.

لا يستخدم أسلوب حل المشكلات، التفكير النقدي أو المناقشة للمفاهيم المرتبطة بإتقان المهارات الأساسية البسيطة التي تعتمد عادة على الحفظ.

من مبادئ نظرية التعلم المعرفي يوجد فروق فردية كبيرة بين التلاميذ في أسلوب التعلم، مدة الانتباه، قوة الذاكرة، سرعة النمو والذكاء.

تطبيقات هذا المبدأ في عمليتي التدريس والتقويم:

ينبغي على المعلم أن:

يقدم عدة خيارات للقيام بالمهمة أو العمل (بدلا من الاعتماد فقط على القرآة والكتابة).

قدم خيارات لكيفية عرض الإتقان أو الكفاية .

يزود التلاميذ بالوقت الكافي للتفكير في المهمة و القيام بها.

عدم الإفراط في زيادة وقت الاختبار أو النشاط بمعنى لا تعطي التلاميذ أكثر من الوقت الضروري لعمل النشاط.

يعطى التلاميذ فرصة لإعادة التفكير وتنقيح أعماله.

يضمن النشاط خبرات عيانية أو حسية (عمل يدوي، روابط للخبرات الشخصية السابقة).

من مبادئ نظرية التعلم المعرفي الناس يعملون بشكل أفضل عندما يعرفون الهدف، يرون نموذج، يعرفون كيف يقارن عملهم بمعايير .

تطبيقات هذا المبدأ في عمليتي التدريس والتقويم:

ينبغي على المعلم أن:

يناقش الأهداف، وأن يستعين بالتلاميذ في تعريف الأهداف.

يزود التلاميذ بفرصة تقويم الذات ومراجعة أعمال بعضهم البعض.

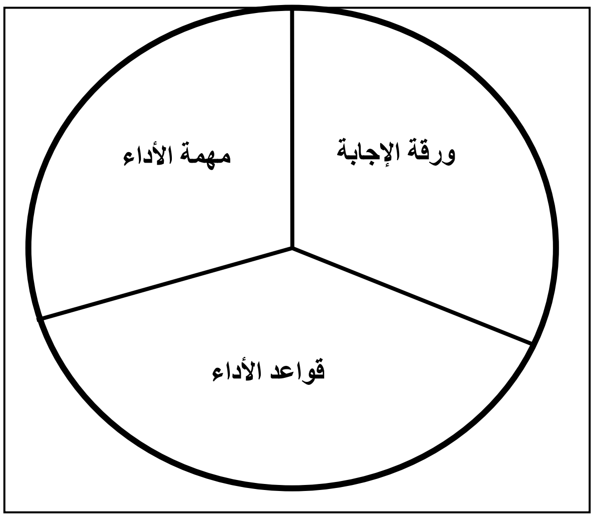
يناقش مع التلاميذ المحكات التي يقوم على أساسها أداءهم.

يسمح للتلاميذ بالإطلاع على المعايير أو الأهداف .

من مبادئ نظرية التعلم المعرفي من المهم أن تعرف متى تستخدم المعرفة ، كيف تكيفها وكيف تدير تعلمك .
تطبيقات هذا المبدأ في عمليتي التدريس والتقويم:
ينبغي على المعلم أن:
يقدم فرص حقيقية (أو محاكاة) لتطبيق أو تكييف معارف جديدة.
يجعل التلاميذ يقومون أعمالهم :وأن يفكروا كيف يمكن أن يتعلمون بشكل جيد ، وأن يضعوا أهداف جديدة لماذا يفضلون عمل محدد.
من مبادئ نظرية التعلم المعرفي كل من الدافعية و الجهد ،وتقدير الذات تؤثر على التعلم والأداء.
تطبيقات هذا المبدأ في عمليتي التدريس والتقويم:
ينبغي على المعلم أن:
يستثير دافعية التلاميذ بمهام مستمدة من الواقع وترتبط بخبراتهم السابقة.
يشجع التلاميذ على رؤية الارتباط بين مقدار الجهد المبذول ومستوى النتيجة.
من مبادئ نظرية التعلم المعرفي التعلم يشتمل على عناصر اجتماعية العمل الجماعي قيم ومفيد.
تطبيقات هذا المبدأ في عمليتي التدريس والتقويم:
ينبغي على المعلم أن:
يشكل مجموعات عمل.
يجعل كل مجموعة غير متجانسة
يمكن التلاميذ من القيام بادوار مختلفة
يأخذ بعين الاعتبار العمليات والنتائج التي تتوصل لها المجموعة .

4- مكونات الاختبارات المعتمدة على الأداء

تشتمل الاختبارات الأدائية على ثلاث عناصر أساسية هني مهمة الأداء، معايير التقويم Rubric و ورقة الإجابة، انظر (الشكل 4.1) .



شكل (4- 1)

Brown and Shavelson, (1996), Assessing Hands-On Science: A Teacher's Guide to Performance Assessment.

4.1 المهمة المعتمدة على الأداء:

تعرف إدارة التربية والنمو المبكر في الاسكا ADEED(1996) مهمة الأداء بأنها نشاط تعليمي يتم تصحيحه بناء على معايير محددة"(ص 10) وتتميز المهمة بأنها تشجع التلاميذ على إنتاج مكون جديد أو الانخراط في أنشطة ذات مردود تعليمي يمكن ملاحظته وقياسه(Wangsatorntanakhun,1997).

يمكنك بطبيعة الحال بناء المهمة أو اختيارها ، إذا اخترت أن تصمم المهمة بنفسك ، خذ بعين الاعتبار أن تصميم مهمة تقويمية جيدة تتطلب أولا التفكير في محتوى المنهج لوضع المخرجات التعليمية المطلوبة ثم تصميم أنشطة أدائية تسمح للتلاميذ ببيان مدى تحصيلهم لتلك الأهداف وتحديد معايير لتقويمها" (Cohen, 1995, p1).

وضع هيرمان وآخرون (Herman et al. (1992 عشر خطوات لتصميم مهمة تقويمية. كالتالي:

1. حدد بشكل واضح الأهداف من التقويم.
2. حدد بوضوح المخرجات التعليمية التى تريد قياسها.
3. ادمج طريقة التقويم مع طريقة التدريس واتجه للخطوة رقم 2.
4. قم بوصف المهمة وما تتطلبه من قيام التلاميذ بمهارات وإنجازات معينة.
5. حدد المعايير للحكم على أداء التلاميذ للمهمة التي حددت أوصافها في الخطوة السابقة.
6. طور سلالم التقدير لتقدير مستوى الأداء على أن تتسم بقدر من الثبات إذا استخدمت من قبل آخرين في مواقف مشابهة.
7. تجنب الغموض أو اللبس الذي يمكن أن يهدد جوانب الثبات والصدق مما قد يؤدي إلى عدم فهم التلاميذ للمهمة.
8. اجمع بعض الأدلة أو المعلومات التي توضح أن التقويم ثابت وصادق.
9. تأكد من صدق النتائج التى حصلت عليها .
10. استخدم نتائج التقويم لتحسين أساليب التقويم وتطوير المنهج وطرائق التدريس.

ومع أن كل الخطوات السابقة مهمة ، فإن الخطوتين رقم 5 و6 لهما أهمية قصوى في تصميم مهمة التقويم، لذلك سوف توضح بشكل موسع فيما يلي:

4.2 المعايير:

المعايير كما عرفها المركز الوطني للبحث ، والتقويم ، والمعايير، واختبارات الطلاب (NCRESST,1996) هي "دليل، وقواعد، وخصائص أو أبعاد تستخدم للحكم على جودة أداء التلميذ (Laboratory[NCREL] ,n.d.) لذلك فان تصميم أو بناء معايير يهدف بشكل أساسي إلى تركيز الانتباه والجهد على سلوك التلميذ القابل للملاحظة والقياس (Anne, 2001) .

أي مهمة تقويم أداء يجب أن يكون لها معايير على الأقل لسببين أولا لتعريف التلاميذ بالأداء المرغوب والأهداف المتوقعة، وثانيا لأنها سوف تسمح لكل من المعلم والتلميذ على حد سواء بتقويم أدائهم (Allen,1996) وهذا ما يقول به هيرمان وآخرون(Herman et al. (1992 حيث يعتقدون أن التلاميذ يتحسن أداؤهم إذا عرفوا الأهداف التعليمية المقصودة وزودوا بمثال توضيحي لمقارنة أعمالهم بالمعايير المطلوبة للأداء ولكيفية بناء المعايير يقترح اريزين (Airasian (1991 إتباع الخطوات التالية:

- حدد الأداء الكلي أو المهمة التي سوف "تقوَّم واعملها بنفسك أو تخيل أداءك لها.
- عدد الجوانب الأساسية المهمة للأداء أو المنتج النهائي.
- حاول أن توجز معايير الأداء ليمكن ملاحظتها أثناء أداء التلاميذ.

- ناقش مع مجموعة من المعلمين تحديد العناصر الأساسية التي تتضمنها المهمة ،إذا كان ذلك ممكنا.
- جرب المعايير التي وضعتها من حيث قابليتها للملاحظة والقياس أو القدرة على تحديد خصائص الناتج النهائي.
- لا تستخدم العبارات الغامضة التي قد تؤدي إلى عدم فهم أو استخدام المعايير.
- نظم معايير الأداء بشكل يجعلها قابله للملاحظة (Amy,1998,p2).

مما لاشك فيه أن أفضل معايير يمكن بناءها لتقويم أداء التلاميذ هي تلك التي تعتمد على توقعات المعلم لأداء تلاميذه ، وتحتوى على تعريف واضح وشامل لمجال الأداء أو الخصائص التي سوف.تقوم "كل معيار يوضع يجب أن يكون قابل للتدريس بمعنى أن المعلم يمكن أن يساعد التلاميذ على تنمية قدراتهم على استخدام المعيار عند تدريس المهمة التي تتطلب ذلك المعيار وتقويمها (Popham ,1997, p 5) إذا كانت معايير الأداء معرفة بشكل جيد وزودت بأمثلة قدر الإمكان فإن التلاميذ سوف يفهمون ماذا يجب عمله للوصول لمستوى عالي من الأداء(Allen, n.d.) .

قد يتخذ تصميم معايير الأداء عدة صور ، إلا أن أكثر أنواع المعايير شيوعا ما يسمى بالمعايير الموزعة على درجات (scoring criteria) أو معايير التقويم "rubric" وفيما يلي نبذه عنها :

4.1.2 معايير التقويم:

وتعرف بأنها مقياس متدرج من المحددات تحدد للمعلم والتلميذ بشكل واضح كيف تبدوا مستويات الأداء المقبول وغير المقبول (Pate, Homestead, & McGinnis,1993) يمكن تقريب مفهوم معايير التقويم بمقارنتها بمفتاح الإجابة في الاختبارات التقليدية ، فكما أن الاختبارات التقليدية مثل أسئلة الاختيار من متعدد لها مفتاح إجابة يحتكم إليه لتصحيح إجابات التلاميذ ، فان الاختبارات المعتمدة على الأداء لها معايير أداء يقوم على أساسها أداء التلميذ والفرق الأساسي بينهما أن مفتاح التصحيح يتطلب إجابة واحده صحيحة بينما معايير التقويم تتطلب مستوى محدد للأداء له مدى معين و قد يتضمن أكثر من إجابة واحدة صحيحة كما هو موضح في الشكل أدناه يمكن ملاحظة عدم وجود إجابة واحدة على إنها هي الإجابة الصحيحة بل يمتد مستوى الإجابة المقبولة على عدة مستويات تتدرج من المستوى العالي (مستوى 4) إلى أن تصل إلى أدنى مستوى (اقل من مستوى1) أيضا يمكن توزيع هذه المستويات على شكل عبارات وصفية مثل (ممتاز. جيدا جدا ، جيد ، مقبول .) أو ما يشابهها .

المحتوى	المستوى 4	المستوى3	المستوى2	المستوى1	اقل من المستوى1
المعرفة والفهم الدائرة الكهربائية ، التيار الكهربائي، فرق الجهد الكهربائي -رسم الدائرة الكهربائية	وضح فهم كامل للدائرة الكهربائية بين كفاءة عالية في استخدام مفاهيم ومصطلحات الوحدة	وضح فهم كبير للدائرة الكهربائية ، لا أخطاء في استخدام مفاهيم ومصطلحات الوحدة	بين بعض الفهم للدائرة الكهربائية ، وقع في بعض الأخطاء عند استخدامه لمفاهيم ومصطلحات الوحدة	بين فهم ضعيف للدائرة الكهربائية ، وقع في العديد من الأخطاء عند استخدامه لمفاهيم ومصطلحات الوحدة	يحتاج إلى مساعدة

معايير التقويم الجيد لا يكتفي بها فقط في تقويم أداء التلميذ بل يمكن الاستفادة منه كما أشار Herman et al. (1992) في الأمور التالية:

تساعد المعلم على تعريف الأداء المتميز وكيفية تحقيقه.

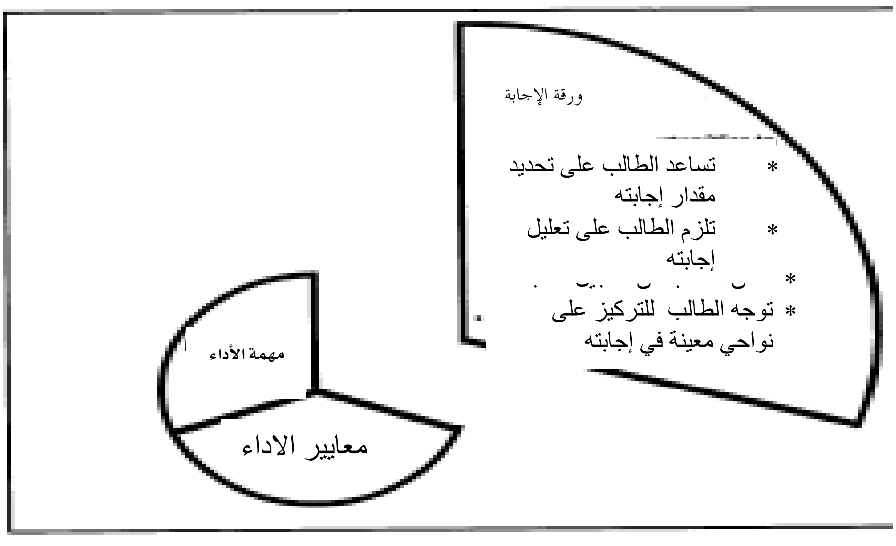
- توضح للتلاميذ كيف يجودوا عملهم وكيف يقومونه أيضا.
- تبين لأولياء الأمور وغيرهم من المهتمين نوع العلاقة بين الأهداف والنتائج.
- تساعد المعلمين وغيرهم من المقومين لعمل التلاميذ كيف يكونوا دقيقين ،وموضوعيين ومتسقين في توزيعهم للدرجات.
- توثق الإجراءات التي استخدمت للحكم على مستوى التلميذ.
- يمكن أن يستخدمها التلاميذ كأداة لتنمية قدراتهم .

بما أن معايير التقويم تعمل كدليل للمعلم والتلميذ. فانه يفضل أن يطلع عليها التلاميذ قبل أداء المهمة بهدف تحفيزهم على التفكير في الطريقة التي سوف يقوم بناء عليها أدائهم.

معايير التقويم عادة قد تتخذ إحدى صورتين إما تحليلية أو كلية ، التحليلية تجزئ الأداء إلى عدة عناصر يقوم كل منها بشكل منفرد ، بينما بالطريقة الكلية يقوم عمل التلميذ بشكل كلي (Herman et al. 1992), على أن استخدام أي من النوعين يتوقف على عدة عناصر، كنوع الموضوع ،وعدد التلاميذ و نوع المهمة إلى غير ذلك ، إلا أنه بشكل عام يفضل استخدام الطريقة الكلية مع تلاميذ المرحلة الابتدائية

4.3 – نموذج الإجابة:

تعد ورقة الإجابة من المكونات الأساسية لمهمة الأداء، حيث تتيح للتلميذ تنظيم جهوده وتوضيح أفكاره أو استنتاجاته، وذلك لاحتوائها على عدد من التعليمات التي يجب إتباعها أو الأسئلة التي يتطلب الإجابة عليها وقد تتخذ ورقة الإجابة عدة صيغ بناء على الأسلوب المتبع في تقديم المهمة للتلميذ، فعلى سبيل المثال المهمة القائمة على أسلوب حل المشكلات قد تختلف في طريقة عرضها عن المهمة المبنية على أسلوب الاكتشاف ويلخص (1996) Brown & Sahvelson في الجدول التالي أهم خصائص ورقة الإجابة



شكل (4- 2)

Brown & Sahvelson (1996)Assessing Hands-On Science: A Teacher’s Guide to Performance Assessment.

5- اختيار مهمة التقويم :

يقترح العديد من التربويين(Allen,1996; Wangsatorntanakhun,1997) اختيار مهام التقويم المناسبة بدلا من إعدادها إذا كان المعلم يستخدم لأول مرة طريقة الا قواعد الأداء ـة على الأداء وتكييفها بعد ذلك بحيث تلبي الأهداف التي يسعى لتحقيقها ولهذا الهدف تم وضع بعض المعايير التي يمكن أن تساعد في عملية الانتقاء، وهي:

- هل المهمة تماثل المخرجات التعليمية (الأهداف) التي تسعى لقياسها؟
- هل المهمة تتطلب من التلاميذ استخدام مهارات التفكير كمهارات التفكير النقدي مثلا؟
- هل المهمة قيمة بحيث يمكن استخدامها أثناء الحصة؟
- هل التقويم يستخدم مهام جذابة للتلاميذ وترتبط بالواقع؟
- هل المهمة يمكن استخدامها لقياس عدة مخرجات تعليمية في وقت واحد؟
- هل المهمة عادلة وغير متحيزة؟
- هل يمكن أن تكون المهمة صادقة ؟
- هل المهمة عملية (أي قابلة للتطبيق من حيث الزمان، والمكان وتوفر الأدوات) ؟
- هل المهمة عرفت بشكل جيد؟

إن أفضل إجابة يمكن الحصول عليها لتلك التساؤلات هي ما تتفق مع الخصائص التالية للمهمة -

الفاعلية	المهمة تناسب محتوى المنهج تتناول موضوعات أساسية في المنهج	ضد	العرضي
حقيقية(واقعية)	المهمة تستخدم إجراءات مناسبة للدرس. التلاميذ يثمنون المخرجات التعليمية للمهمة.	ضد	مفتعل
ثرية	تقود المهمة إلى أخريات. تثير أسئلة أخرى. لها العديد من الاحتمالات.	ضد	سطحية
جذابة	المهمة يعتقد أنها مثيره. تدعو إلى الإصرار.	ضد	مملة
نشط	التلميذ يعمل ويتخذ القرار. التلميذ يتفاعل مع زملائه. التلاميذ يبنون معاني ويكونون فهم متعمق لموضوع معين.	ضد	غير فعال
معقولة	يمكن عمل المهمة خلال الحصة . مناسبة لنمو التلاميذ آمنه	ضد	غير معقولة
منصفة	تعمل المهمة على تنمية التفكير بأساليب مختلفة. تساهم في تكوين اتجاهات ايجابية	ضد	جائرة
مفتوحة	للمهمة أكثر من إجابة واحدة صحيحة . لها مدخل ذو تشعبات عديدة ، متاحة لكل التلاميذ.	ضد	مقفلة

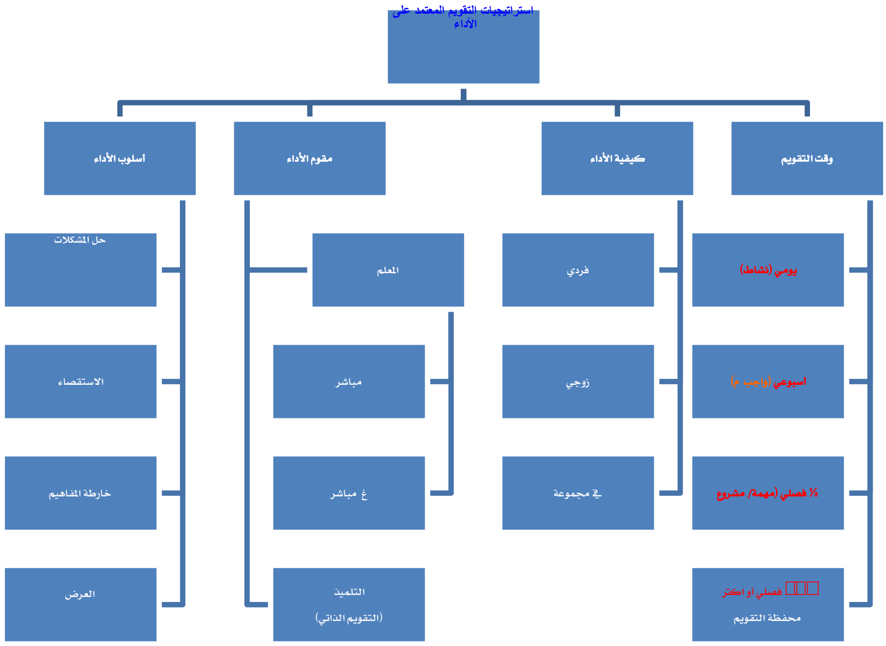
(In ADEED,1996)

6- وصف برنامج التقويم المعتمد على الأداء

تم إعداد برنامج التقويم المعتمد على الأداء ليستخدم مع تلاميذ الصف السادس الابتدائي في المملكة العربية السعودية هذا الجزء الوصفي سوف يتضمن قسمين، القسم الأول يصف الاستراتيجيات التي تم إتباعها لبناء البرنامج بناء على الخلفية النظرية للتقويم المعتمد على الأداء مما سوف يوفر لمدرسي العلوم المعنيين بتطبيق هذا البرنامج بعض الأسس النظرية التي قامت عليها تلك الاستراتيجيات أما القسم الثاني فيزود المعلم بدليل لكيفية استخدام البرنامج وما يجب إتباعه لتطبيق كل عنصر من عناصره، عند استخدام استراتيجيات التقويم المعتمد على الأداء في الصف .

6.1 استراتيجيات التقويم المعتمد على الأداء

قسمت استراتيجيات البرنامج إلى أربعة عناصر أساسية كما يبين الشكل (6- 1) وهي طرائق التعلم، مقوم الأداء، كيفية الأداء و وقت التقويم يجب التنويه إلى أن هذا التقسيم الافتراضي لا يلغى الطبيعة التكاملية بين هذه العناصر.



شكل (6- 1)

فيما يلي عرض مختصر لكل عنصر من العناصر الأربعة:

6.1.1 أساليب الأداء:

يمكن أن يتخذ أداء التلاميذ داخل الصف عدة أساليب بناء على طبيعة الموضوع ونوعية الأهداف وما إلى ذلك من العوامل الأخرى التي يجب أخذها بعين الاعتبار عند التخطيط لاختيار احد أساليب الأداء التي تعد أداة للتدريس والتقويم في نفس الوقت وضوح الأهداف التعليمية وما يتوقع أن يترتب عليها من مخرجات تعليمية يعد عامل مهم في اختيار الأسلوب المناسب إضافة إلى ذلك عند اختيار أحد الأساليب المناسبة يجب الأخذ بعين الاعتبار أن تكون عمليات التقويم بسيطة ومناسبة ولا تتطلب من التلميذ القيام بأكثر مما ينبغي، بمعنى أخر يجب الالتزام بتنفيذ الأهداف التعليمة باعتبارها الهدف الأساسي المطلوب من المعلم

والتلميذ على حد سواء و تجنب ما زاد عن ذلك كأن يطلب من التلميذ جمع بيانات إضافية ليس لها علاقة بأهداف الدرس.

فيما يلي عرض مبسط لأهم الأساليب الحديثة المستخدمة لتدريس مادة العلوم في المرحلة الابتدائية ، والتي سوف تستخدم في هذا البرنامج باعتبارها أكثر الأساليب ملائمة لاستخدام التقويم المعتمد على الأداء

6.1.2 أسلوب حل المشكلات

يعرف أسلوب حل المشكلات بأنه عبارة عن سلسلة من العمليات المعرفية والمهارات يستخدمها المتعلم للوصول إلى هدف معين (حل المشكلة) عندما يكون ذلك الهدف غير متاح أمامه(Rothstein,1990) حل المشكلات كطريقة للتدريس يشير إلى تحفيز التلاميذ على استخدام عمليات عقلية عليا لتعلم مادة العلوم ، عن طريق طرح اسئلة ذات علاقة بالموضوع المطروح ، القيام بعلميات استكشاف، صياغة فروض، وضع خطة للتحقق من صحة الفروض، توقع مخرجات معينة ، إجراء تجربة، جمع المعلومات وتقويمها وصياغة استنتاجات معينة (Lee , Tan, Goh, Chia, & Chin,2000) .

وعلى الرغم من أن أسلوب حل المشكلات من أكثر الأساليب التي ينادى باستخدامها لتدريس مادة العلوم إلا أن العديد من الدراسات (Appleton,1995; Lee, Tan, Goh, Chia, & Chin,2000) أوضحت أن المعلمين لا يميلون إلى استخدام هذا الأسلوب في الصف، السبب في ذلك طبقا لدراسة لي وآخرون Lee et al. (2000) ترتبط بعوامل داخلية (شخصية) وأخرى خارجية من أهم العوامل الشخصية ضعف المهارات والمعارف لدى المعلم للتدريس بهذا الأسلوب، وضعف الثقة بالنفس، أما العوامل الخارجية فمن أهمها ضيق الوقت ، وضعف قدرات التلاميذ ونقص الدعم اللازم من إدارة المدرسة .

أسلوب حل المشكلات متاح استخدامه يوميا من قبل التلاميذ ، فالكثير من المواقف اليومية التي يواجهها التلميذ تتطلب منه استخدام بعض خطوات أساليب حل المشكلات لذا فان استخدام هذا الأسلوب بشكل علمي في الصف قد لا يعد أمرا غير مألوفا للتلاميذ ، لذلك فكل ما يمكن أن يفعله المعلم هو إعادة توظيف علاقات التلميذ الاجتماعية ،و مهاراته المعرفية وخبراته ليستخدمها بشكل منظم وفعال لتحقيق أهداف تربوية مفيدة .(Joan,1993; Taconis, Hessler, & Broekkamp,2001)

يمكن أن يستخدم التلاميذ بشكل فردي أو في مجموعات أسلوب حل المشكلات من خلال إتباع عدد من الخطوات البسيطة، مثل:

- الشعور بالمشكلة
- تحديد المشكلة
- استخدام أسلوب العصف الذهني لاستعراض عدد من الحلول.
- اختيار حل واحد ومحاولة أدائه.
- تقويم الحل وطريقة أدائه Joan (1993) .

اقترح جوفن Goffin(1985) بعض الأسئلة التي يمكن للمعلم أن يستخدمها كدليل لتحديد المشكلة المناسبة طرحها على التلاميذ:

- هل المشكلة مفيدة ومشوقة؟
- هل يمكن أن تحل بعدة طرائق؟
- هل يجب اتخاذ قرار جديد بشأنها؟
- هل يمكن تقويم مراحل حل المشكلة؟ .(as cited in Joan, 1993)

ونظرا لأهمية أسلوب حل المشكلات والتشجيع على استخدامه طورت عدة مداخل جديدة لاستخدامه، لعل من أهمها مدخل التعلم المعتمد على المشكلة (Problem-Based Learning (PBL ، وهو أسلوب بدأ

استخدامه في مدارس الطب وأعيد تكييفه ليستخدم في تدريس العلوم للمرحلة الابتدائية (Gallagher & Stepien,1995).

ويرى مستخدمو هذا الأسلوب انه بالرغم من أن المشكلة ممكن أن تتخذ عدة صور، إلا أن هناك ثلاثة عناصر أساسية تتكون منها وهي أولا الحالة المبدئية أو الحاضرة التي ينطلق منها التلاميذ، ثانيا الهدف الذي يسعون للوصول إليه، ثالثا العمليات التي يجب القيام بها وتتضمن الانتقال من العنصر الأول إلى الثاني لتحقيق الهدف(Greenwald, 2001) .

في المدخل التقليدي لحل المشكلات، تعرض المشكلة على التلاميذ بعد تدريس المفاهيم المرتبطة بموضوعها وتوفير المعلومات والأدوات اللازمة لحلها ، بينما في مدخل التعلم المعتمد على المشكلة يبدأ التعلم بعد عرض المشكلة فهذا المدخل يعتمد على مدى وضوح عناصر المشكلة التي سبق ذكرها، وهو يقوم على افتراض أن المشاكل التي نواجهها في واقع الحياة قد لا تتوفر المعلومات الكافية للتعرف عليها ومواجهتها ، لذلك إذا كان التعليم يجب أن يعكس مواقف الحياة الفعلية فان المشكلة التي تعرض للتلاميذ يجب أن تكون غامضة لحد ما ill-defined لتثير بذلك أسئلة حول ما هو معروف من عناصرها، ومدى الحاجة الى معرفة المزيد عنها ومن ثم كيفية التوصل إلى حلها (Greenwald,2001)

وبشكل عام فان استخدام أي من مداخل أسلوب حل المشكلات لتدريس مادة العلوم له العديد من الفوائد، كما يفترض ذلك جون Joan (1993) ، حيث يرى أن حل المشكلات أسلوب لفهم طبيعة البيئة والتحكم فيها فهي عبارة عن إجراء يسمح للتلاميذ في ظل عالم متغير من أن يكونوا مشاركين فاعلين لإحداث التغير المنشود فبإدخال أسلوب حل المشكلات للصف الدراسي في المرحلة الابتدائية نكون قد زودنا التلاميذ بالمهارات الحياتية المفيدة لكل ميادين التعلم

6.1.1.2 أسلوب الاستقصاء Inquiry

يعتبر هذا الأسلوب من أكثر الأساليب استخداما لتدريس مادة العلوم لما يتسم به من فاعلية في تنمية تفكير التلاميذ وقد وصف المركز التربوي للمعايير التربوية The National Science Education Standards (1996) الطريقة الاستقصائية بأنها عبارة عن نشاط متعدد الأوجه يتضمن القيام بعمليات ملاحظة طرح أسئلة ، اختبار كتاب أو مراجع أخرى علمية ، لاستكشاف ما يعرفه التلميذ بالفعل، التخطيط لعملية الاستقصاء مراجعة ما يعرفه التلميذ في ضوء الأدلة التجريبية ، استخدام أدوات لجمع، تحليل وتفسير المعلومات، اقتراح الحلول، التفسيرات والتوقعات، وتقديم النتائج الطريقة الاستقصائية تتطلب تحديد الافتراضات، استخدام التفكير المنطقي والأخذ بعين الاعتبار وجود تفسيرات أخرى بديله (Fetters, Beller, & Hickman ,2003).

الطريقة الاستقصائية تقدم طريقة فريدة للتدريس يستفيد منها كل التلاميذ على حد سواء، ولكن ما هي هذه الطريقة الفريدة للتدريس؟ وكيف يسهم الأسلوب الاستقصائي في تشكيلها ؟ هيبرنك (Hebrank,2000) من مركز التعلم المعتمد على الاستقصاء في جامعة دك Duke University يحدد معالم ذلك الأسلوب الفريد في تسعة عناصر كما يبين كيفية اتساق الطريقة الاستقصائية مع كل عنصر، وفيما يلي موجز لأهم تلك العناصر :

1- العلوم تدرس كعمليات كما تدرس كمحتوى معرفي:

العلوم عبارة عن عمليات منظمة من الاكتشاف تتعلق بالظواهر الطبيعية، وهي عندما تدرس كعمليات استقصائية فان التلاميذ يتعلمون كيف يكونون علماء كذلك عندما يستخدم التلاميذ الطريقة الاستقصائية لاستكشاف محتوى علمي معين فإنهم لا يتعلمون فقط كم هائل من الحقائق والمفاهيم

المختلفة بل يتعلمون أيضا كيف ترتبط هذه الحقائق والمفاهيم ببعضها البعض كما يدركون كيف نحن كجنس بشري نساهم من خلال سعينا لفهم العالم الذي نعيش فيه إلى إضافة معلومات جديدة لما يسمى بالمعرفة العلمية

2. محتوى العلوم الذي يدرس يرتبط بتجارب التلاميذ اليومية ،و يمكن أن يستغل لإثارة فضول التلاميذ وأسئلتهم والتشجيع كذلك على طرح مزيد من الأسئلة .

تلاميذ المرحلة الابتدائية وخاصة الصفوف المتقدمة يعيشون مرحلة انتقالية من المحيط الأسري الصغير إلى المجتمع الكبير بما يحفل من متغيرات عديدة لذلك قبل أن يشكلوا أنماط تفكيرهم لتكييف مع المجتمع الكبير ، يحتاجون عادة إلى فهم محتويات هذا العالم الكبير بالنتيجة تجد لديهم العديد من التساؤلات، يريدون أن يكتشفوا كيف يسير العالم من حولهم .

طريقة الاستقصاء تتمحور حول طرح الأسئلة ، لذلك فان التلاميذ يمكن تشجيعهم على التساؤل، مما يساعده م على اكتشاف العالم الذي يعيشون فيه.وممارسة طرح أسئلة جيدة يمكن الحصول لها على إجابات مفيدة وبذلك فان هذه الطريقة تعطي التلاميذ الفرصة للممارسة هذه الخبرات في الصف والحصول على التعزيز الفوري من خلال اكتشاف إجابات لأسئلة قد يرون أنها مثيره للتحدي.

التدريس يزيل أو يقلل الاعتماد على أسلوب التلقين والكتاب المدرسي

طرائق التدريس التقليدية ترى أن عقول التلاميذ كالإناء الفارغ المعلم يمكن أن يملاءها بمعلومات نقية والتلاميذ بعد ذلك سوف يتمكنون وبشكل مباشر من الفهم و التذكر بل والقدرة على القيام بتطبيقات جديدة نحن أصبحنا حاليا نعلم أن هذا الأسلوب الذي يحول التلميذ إلى مبنى للمجهول ببساطة لا يفيد مع الغالبية العظمة من التلاميذ بدلا من ذلك التلاميذ يريدون أن يكونوا فاعلين يعملون عقولهم وأيديهم في ممارسات يمكن أن يتمكنوا من خلالها بناء معارفهم.

الطريقة الاستقصائية تقدم خبرات تعليمية عيانية من خلال القيام بأنشطة تعليمية ، كذلك تعطى التلاميذ الفرصة لتطوير مبادرة، حل مشكلة، اتخاذ قرار وكذلك تعلم المهارات البحثية اللازمة لأن يكونوا باحثين عن المعرفة على المدى الطويل.

طرائق التدريس تأخذ بعين الاعتبار الفروق الفردية لنمو التلاميذ

التلاميذ في الصفوف الأخيرة من المرحلة الابتدائية يبدأون في الانتقال من عمليات التفكير العياني الى المجرد ومع ذلك فالتفاوت قد يكون كبيرا ليس فيما بينهم ولكن أيضا داخل الفرد الواحد على سبيل المثال أحد التلاميذ قد يكون قادرا على حل عملية حسابية متعددة المراحل مما يشير إلى تمتعه بمستوى عالي من التفكير التجريدي في الرياضيات ولكن ربما يواجه مثلا صعوبة في فهم محتوى الذرة قي مادة العلوم ، تلميذ آخر في نفس الصف قد يعانى من صعوبة في حل مسألة رياضية ذات مرحلة واحده لأنه بدأ بالكاد الانتقال من مرحلة التفكير العياني إلى المجرد لذلك كل دروس العلوم يجب أن تكون مرنه بشكل كاف لمراعاة الفروق المعرفية بين التلاميذ.

الطريقة الاستقصائية بطبيعتها مرنه، التلاميذ يتناولون الأسئلة أو الأجزاء التي يرون أنفسهم قادرين عليها ويحاولون الإجابة عليها باستخدام الأدوات المناسبة لهم في مادة العلوم عادة يوجد مداخل عديدة لحل المشكلة عندما يترك للتلاميذ الحرية لاستخدام قدراتهم الإبداعية تجدهم يتجاوزون إمكاناتهم العلمية لحل المشكلة ويتوصلون إلى مداخل عديدة مبتكرة لحل المشكلة.

الاختبارات المعتمدة على الأداء تسمح للتلاميذ بعرض مهاراتهم بطرائق مختلفة

كما أن التلاميذ يختلفون في نموهم المعرفي ، يتمايزون أيضا في أساليب تعلمهم، وقدراتهم العلمية والأدبية وكذلك في ميولهم البعض منهم ربما قوي في المهارات اللفظية و قد يعكس هذا التميز في مقالة يكتبها ،

بينما آخرين قد تكون قدراتهم اللفظية ضعيفة إلا أنهم يستطيعون أن يعرضوا المفاهيم في شكل بياني البعض الآخر ربما لدية القدرة على المقارنة والمناظرة بين المعلومات باستخدام الرسوم البيانية . فيما يستطيع البعض أن يستخدم ملخص بسيط لاستنباط أفكار علمية بنفس الطريقة التي يجب أن يكون درس العلوم مرن . فأساليب التقويم يجب أن تكون مرنه و متباينة بشكل يسمح لكل تلميذ استغلال نقاط القوة لديه لتوضيح ماذا تعلم بالفعل.

الطريقة الاستكشافية تسمح للتلاميذ بعرض تحصيلهم بطرائق متعددة، العلماء يستخدمون أساليب مختلفة لعرض أو توصيل مكتشفاتهم للآخرين وكذلك يمكن أن يفعل التلاميذ كتابة ورقة أو مقالة، تقرير لفظي، رسم بياني ملون وجداول كل ذلك يمكن أن يستخدمه التلاميذ لبيان ما تعلموه بما أن جزء كبير من التعلم يتعلق بعمليات الاستكشاف، التلاميذ يمكن و أيضا يجب أن يقوموا بناء على مدى تقدمهم من صياغة فروض ، تصميم تجربة، وتحليل نتائج التقويم المعتمد على الأداء يصبح أمر ضروريا لتقويم هذه المهارات لتقديم صورة واضحة ومتكاملة لمستوى التحصيل الحقيقي للتلاميذ بدلا من الاكتفاء بجزئيات صغيره باستخدام أساليب التقويم التقليدي

الطريقة الاستقصائية لتدريس مادة العلوم يمكن أن تتداخل مع المواد الأخرى

مادة العلوم لا يمكن تدريسها بشكل انعزالي، فهي تتأثر بشكل كبير بالبيئة الثقافية التى تمارس فيها معظم انتاج البحث العلمي درس بشكل مباشر أو غير مباشر المشاكل المنبثقة من المحتوى الاجتماعي، والتلاميذ يمكن أن يواجهوا هذه المشكلات داخل الصف من خلال دراستهم للجغرافيا مثلا إضافة إلى ذلك البحث العلمي استخدم أدوات من فروع دراسية أخري لعل الرياضيات أكثرها وضوحا.

الطريقة الاستقصائية يمكن تطبيقها بسهولة على أسئلة تثار في مواد أخرى يواجهها التلاميذ بشكل يومي في أحيانا كثيرة معلم العلوم يمكن أن يشارك ويخطط لوضع أسئلة تثار بشكل طبيعى في البيئة المحيطة بالمثل يمكن استخدام بعض مفاهيم الرياضيات كأداة بناءة في الاستكشاف العلمي كعمليات القياس وتحليل البيانات.

6.1.1.4 العرض (التقديم)

يأخذ التلاميذ العديد من الأنشطة التعليمية التي تتضمن القيام ببعض الإجراءات، حيث يقومون بجمع المعلومات وتنظيمها، وتحليلها بهدف الوصول إلى ما يحتاجون منها لتحقيق أهداف معينة ثم بعد ذلك يشكلون من العناصر المتناثرة كل متكامل يسجلون المادة بأسلوب يختارونه ليتم من خلاله تقديم عمليات تعلمهم بأفضل الطرائق الممكنة كما يتواصلون مع المستمعين أو الحضور ليوضحوا ماذا تعلموا مستخدمين في ذلك العديد من الوسائل السمعية والبصرية إضافة إلى ذلك فان القيام بعملية العرض تجعل التلاميذ ينجذبون إلى المادة التي تعلموها (Saskatchewan Education, 1991 .

إضافة إلى ذلك، العرض يزود التلاميذ بالفرصة لعرض مجال واسع من مهارات الاتصال (التواصل الاجتماعي) ليتواصلوا علميا مع الآخرين و يبينوا من خلال الشرح والإيضاح وربما أحيانا الإجابة على أسئلة الحضور مدى فهمهم للظاهرة العلمية موضوع العرض ويطبقون كذلك معارفهم العلمية) curriculum@work)

هذا الأسلوب يقدم أيضا ظروف مثالية لتقويم مدى تقدم التلاميذ من النواحي المعرفية والمهارية والاتجاهات على انه يجب التنويه إلى أن بعض التلاميذ ربما يواجهون صعوبة في تقديم عرض أمام المعلم أو زملائهم ، لذلك يقدم Saskatchewan Education (1991) الإرشادات التالية لتقويم العرض

أ-التلاميذ يجب أن يعرفوا كيف سيتم تقويم أدائهم.

ب-بعض التلاميذ ربما ليس لديهم الثقة الكافية بالنفس للوقوف أمام الصف لذلك يجب على المعلم أن يأخذ بعين الاعتبار التساؤلات التالية قبل الإقدام على تقويم أدائهم:

هل هيأت الظروف المناسبة الداعمة للتلميذ في الصف بحيث يشعر بالثقة و توفر له الاستقبال الحسن من زملائه؟

هل لدي في الصف تلاميذ لديهم صعوبات ممكن أن تعوق قدرتهم على التقديم ؟ إذا كان الأمر كذلك ، ما المعالجة التي يجب أن أقوم بها ليقدموا بشكل جيد؟

هل لدي التصور الكافي عن كيفية تقويم عروض التلاميذ والهدف من تقويمها ؟

هل فكرت كيف أساعد أو اعدل الموقف للتلاميذ الذين يثير هذا النشاط توترهم؟

-6.1.2 مقومين الأداء

6.1.2.1 المعلم:

يمكن أن يقوم أداء تلاميذه بأسلوبين متكاملين، الأسلوب الأول باستخدام معايير التقويم المرفقة مع كل أدوات التقويم التي سبق الحديث عنها ، والأسلوب الثاني عن طريق ملاحظة التلميذ أثناء أدائه للعمل في الصف أو متابعة أعماله التي قد يقوم بها في المنزل

الملاحظة من الأساليب الشائعة للتقويم وخاصة التقويم الاعتيادي (informal) كما يمكن استخدامها لتقويم اتجاهات التلميذ وقيمه نحو مادة العلوم إضافة إلى مهارات التواصل الاجتماعي داخل الصف والمهارات العملية إدارة التربية والنمو المبكر في الاسكا A.D.E.E.D (1996) قدمت بعض الإرشادات المفيدة التالية لاستخدام الملاحظة:

- استخدم الملاحظة لجمع معلومات لأنماط السلوك الذي يصعب تقويمه بالوسائل الأخرى (مثل الاتجاه نحو أسلوب حل المشكلات، القدرة على العمل بشكل فاعل داخل مجموعة العمل، القدرة على التركيز .).
- لاحظ وسجل الطريقة التي يستخدمها التلميذ لحل المشكلة وإنهاء المهمة.
- تأكد أن التلميذ (سواء أكان يعمل بشكل منفرد أو في مجموعه) أحرز الأهداف المقصودة بأدوات أو عمليات ملاحظة .
- سجل وأرخ ملاحظاتك خلال أو مباشرة بعد الملاحظة
- طور طريقة لتسجيل اختصارات يدوية تستخدمها بشكل متكرر .
- لاحظ التلاميذ في الوضع الطبيعي داخل الصف لتتعرف على استجاباتهم في الظروف الطبيعية من السهل ملاحظة سلوك التلاميذ إذا كانوا يعملون في مجموعات عما إذا كانوا يعملون بشكل منفرد.
- اعد خطة للملاحظة ولكن كن مرن بشكل يساعدك على ملاحظة أي سلوك مهم يصدر عن التلميذ ربما تجد من الأفضل تسجيل عدة سلوكيات لتلميذ واحد أو سلوك واحد لعدة تلاميذ.

6.1.2.2 التلميذ

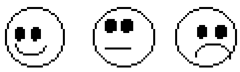
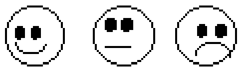
التقويم الذاتي يمكن تعريفه بعملية يفوض خلالها المتعلم بعمل تقويم أو حكم واضح حول مستوى تحصيله أو مدى التقدم الذي أحرزه لتحقيق أهداف تعليمية محددة (Lee & Gavine, 2003) لقد أصبح التقويم الذاتي احد العناصر الأساسية في العملية التعليمية ، فالتلاميذ يحتاجون إلى فرصة لمراقبة تقدمهم الدراسي، وتنظيم جهودهم وتقدير جودة أعمالهم (Luongo,2000) .

بلاك و وليم (Black & Wiliam (1998 وهما من اشهر علماء التقويم الصفي المعاصرين يريان أن التقويم الذاتي ومن خلال نتائج العديد من الدراسات والتطبيقات التربوية التي أكدت النتائج الايجابية لتقويم التلميذ لأعماله لم يعد عملية عرضية بل حتمية يجب تدريب التلاميذ على استخدامها بممارسة التقويم الذاتي ، يقوم التلاميذ بتطوير مهارات عقلية عليا كما يصبحون أكثر مسئوليه عن أعمالهم ومن ثم يعملون على تحسين أداءهم باستمرار(A.D.E.E.D,1996; Luongo ,2000) إضافة إلى ذلك المعلم يمكن أن يحصل على معلومات مهمة عن أداء تلاميذه مما يساعده على تحسين أداء التلاميذ وتطوير طرائق التدريس.

مع ذلك يجب التنويه إلى أن تقويم التلاميذ لأدائهم ليس بالعملية السهلة ، فمن المتوقع أن يواجه التلاميذ صعوبة في تقويم أعمالهم وخاصة للمرة الأولى لذالك كنوع من الهروب من الموقف من المتوقع أن يتعامل التلاميذ مع هذا الأمر بشكل هزلي أو يتجنبوا القيام به، وهنا يأتي دور المعلم لمساعدة تلاميذه وتشجيعهم على أن يقوموا أداءهم بشكل متكرر إلى أن يكتسبوا المهارات الأساسية للتقويم الذاتي ومن العوامل المساعدة على ذلك البدء مع التلاميذ بنماذج بسيطة للتقويم الذاتي تستخدم عادة مع تلاميذ الصفوف المبكرة والتدرج باستخدام نماذج أكثر ملاءمة لمستواهم التعليمي

وفيما يلي عدد من النماذج الأولية التي يمكن أن يزود بها التلاميذ لتقويم أعمالهم

نموذج رقم(1)

كيف تشعر تجاه هذا النشاط 
هل ترغب في أداء هذا النشاط مرة أخرى 

نموذج رقم(2)

أستطيع أن اشرح هذه المشكلة	5 3 1	لم افهم المشكلة
أستطيع أن احدد العناصر المهمة والأجزاء غير المهمة في المشكلة	5 3 1	لا أستطيع أن احدد العناصر المهمة أو غير المهمة في المشكلة
استطيع أن احل المشكلة واشرح طريقة الحل	5 3 1	لا اعرف كيف ابدأ
كانت هذه المشكلة بسيطة	5 3 1	هذه المشكلة صعبة

نموذج رقم (3)

الاسم ______________________________ التاريخ

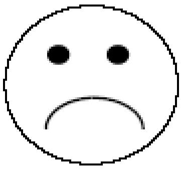
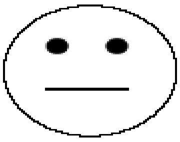
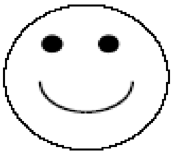
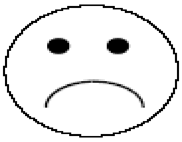
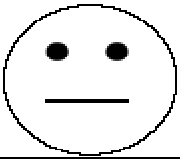
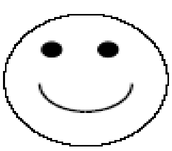
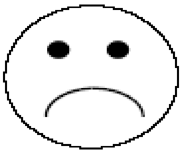
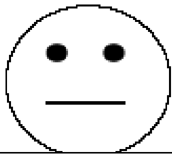
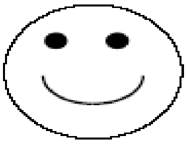
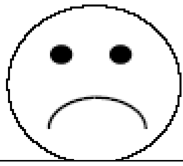
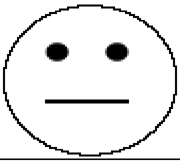
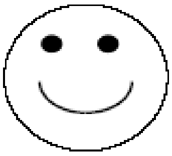
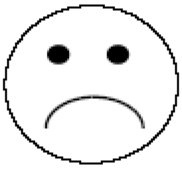
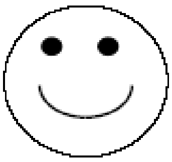
اسم المهمة او المشروع ______________________________

من عمل معي في هذا النشاط؟	
ماذا عملت؟	
هل كان ادائي جيد؟	
كيف اشعر تجاه هذا العمل الآن؟	
ما أفضل جزء في العمل؟	
ما ذا ارغب أن اعمل بعد هذا؟	

Saskatchewan Education (1999)

نموذج رقم (4)

التقويم الذاتي

اتبعت إجراءات إجراء التجربة			
أكملت كتابة الفروض			
أستطيع أن اشرح الآن لماذا يحدث التنافر أو التجاذب بين الأجسام بالدلك			
اشتركت مع المجموعة في إجراء التجربة			
شعوري نحو هذا النشاط			

إذا واصلت العمل في هذا النشاط سوف أحاول أن افهم

....

....

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....

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أفضل شي تعلمته من هذا النشاط هو

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6.1-3 كيفية الأداء

يوجد ثلاثة أساليب لكيفية أداء التلاميذ داخل الصف يمكن أن يعمل كل منهم بشكل منفرد دون اعتبار لأداء زملائه الآخرين، أو العمل بشكل منفرد مع الدخول في منافسة مع زملائه لمقارنة أدائه بأدائهم، أو العمل بشكل تعاوني مع زملائه ضمن مجموعة (Johnson & Johnson,1988) .

في مدارسنا كما هو معلوم ، الطريقة الأولى والثانية هي الأكثر شيوعا ، بينما الطريقة الثالثة نادرا ما تستخدم في الصف هذا ربما يرجع لعدة أسباب منها عدم تلقي المعلم التدريب الكافي على استخدام هذه الطريقة ، ولكن بالتأكيد ليس لاكتشاف أن التعلم الفردي أفضل أساليب التعلم فمعظم الدراسات التي

قارنت بين هذه الطرائق الثلاث وجدت أن التعلم التعاوني أكثر فاعلية من أساليب التعلم الأخرى (Johnson & Johnson,1988; Lawrence & Harvey,1988; Miller & Peterson,2002) .

جونسون وجونسون (1988) Johnson & Johnson راجعا 122 دراسة قارنت بين التعلم الانفرادي، والتنافسي والتعاوني في الفترة بين 1942- 1980 ووجدا إن استخدام التعلم التعاوني يؤدي بشكل دال مقارنة بالأساليب الأخرى إلى:

رفع المستوى التحصيلي للتلاميذ

تكوين اتجاهات ايجابية نحو المعلمين، والمواد والمدرسة .

تكوين اتجاهات ايجابية بين التلاميذ نحو بعضهم البعض.

زيادة التفاعل الشخصي بين التلاميذ كنتيجة لعملهم بشكل تعاوني في مجموعات.

في دراسة أخرى قاما فيها بتحليل نتائج 323 دراسة لأثر أنماط التفاعل الاجتماعي على التحصيل أظهرت النتائج أن أداء التلاميذ بطريقة التعلم التعاوني عند المئين 50 يقابل المئين 75 لأداء التلاميذ بالطريقة التنافسية والمئين 77 لأداء التلاميذ بالطريقة الانفرادية (Sharan,1990) وعندما اقتصر التحليل على الدراسات ذات الجودة العالية، كان أداء التلاميذ عند المئين 50 بالطريقة التعاونية يقابل أداء التلاميذ عند المئين 81 بالطريقتين التنافسية والانفرادية (Sharan,1990).

ولأهمية التعليم التعاوني وانتشاره بشكل واسع في التعليم ، استحدثت العديد من الاستراتيجيات لتطبيقه في مختلف المراحل التعليمية بشكل عام هناك بعض الاعتبارات العامة لاستخدامه:

حجم المجموعة الحجم المناسب للمجموعة يعتمد على عدة عناصر منها، حجم الصف، وقت الدرس، الأدوات المتاحة للاستخدام ومهارات التلاميذ لتطبيق أساليب التعلم التعاوني المجموعة يجب أن تكون صغيرة إذا كان التلاميذ ليس لديهم المهارات الكافية للاتصال،و وقت الدرس اقل من ساعة ويوجد العدد الكافي من الأدوات اللازمة للدرس المجموعة الزوجية تعتبر ابسط صور المجموعة وهي في بعض الأحيان تعتبر حجم مثالي حيث تمكن تلميذين فقط من العمل سويا لحل مشكلة وتبادل الأفكار .

تجانس المجموعة العديد من التربويين (Johnson & Johnson,1988) يرون أن المجموعة غير المتجانسة أكثر فاعلية، فاختلاف حاجات التلاميذ، وقدراتهم واتجاهاتهم يحفز التعليم لميل التلاميذ إلى النقاش والشرح والاستماع إلى أفكار متباينة وصولا للحل المناسب أو الهدف المقصود.

6.1.4 وقت التقويم

التقويم عملية مستمرة، تستمد استمراريتها من تداخلها مع عمليات التدريس والتعلم لذلك إذا كان الهدف الأساسي من التقويم هو الرفع من مستوى تحصيل التلاميذ، فإن التغير الدائم لأساليب التدريس والتقويم يجب أن تتم بشكل يومي(Enrigh,2002) .

التقويم اليومي يمكن أن يزود المعلم بتغذية راجعة سريعة حول مدى تقدم التلاميذ. تمكن المعلم من تحليل حاجات التلاميذ ومساعدتهم على تجاوز الصعوبات التي يواجهونها قبل الانتقال إلى الدرس التالي، وكذلك تمكنه من تعديل أسلوب التدريس ليلبى الحاجات التعليمية للتلاميذ باستخدام أساليب التقويم التقليدية، المعلم عادة يقوم تلاميذه عند نهاية تدريس الوحدة، لذلك إذا لم يفهم التلاميذ محتوى الوحدة فمن المحتمل أن يقوم المعلم بإحدى أمرين، إعادة تدريس الوحدة أو الانتقال إلى تدريس وحدة جديدة مع إغفال التلاميذ الذين لم يفهموا الوحدة السابقة وفي كلا الحالتين جزء من التلاميذ الذين واجهوا صعوبات في فهم الوحدة السابقة سوف يكونون اقل دافعية للتعلم كما سوف يكونون مفهوم سلبي عن ذواتهم لاعتقادهم بأنهم أقل ذكاء وأبطأ فهما من أقرانهم

بلاك و وليم (Black and Wiliam (1998 راجعا عدد كبير من الدراسات في مجال التقويم الصفي ووجدا أن التقويم اليومي الذي يوفر تغذية راجعة يساعد التلاميذ الأقل تحصيلا أكثر من غيرهم، كما يقلل التفاوت بين التلاميذ في مستوى التحصيل الدراسي و يعمل على زيادة مستوى التحصيل الدراسي لكل التلاميذ بشكل عام إضافة إلى ذلك وجدا أن التلاميذ الذين تشكل لديهم اعتقاد بأنهم غير قادرين على التعلم بدأو ينظرون إلى الدراسة بشكل جدي بعد أن كان العديد من هذه الفئة ممزقا والبعض الآخر يلجأ إلى الغياب و معزولين عن المجتمع وضحايا للعديد من المشاكل الاجتماعية (Black & Wiliam,1998).

هذه الأهمية للتقويم اليومي لا يعني أن بقية الأنواع الأخرى اقل أهمية ، في الواقع كل نوع له أهميته الخاصة لكل من عمليتي التدريس والتعلم التقويم الأسبوعي يلعب دورا محوريا في تحقيق أهداف التقويم ، حيث يمكن استخدامه لترسيخ المهارات والمفاهيم التي سبق تدريسها في الصف ، ,وكذلك مراجعة أساليب التدريس وتنمية مسؤولية التلاميذ الذاتية عن تعلمهم إضافة إلى ذلك التقويم الأسبوعي يمكن أن يكيف ليناسب حاجات التلاميذ بحيث يعطى بعض التلاميذ ممن يعانون من صعوبة معينة مهمة تقويمية تذلل هذه الصعوبة على سبيل المثال إذا كان مجموعة من التلاميذ ابدوا صعوبة في فهم تكوين الدائرة الكهربائية ومجموعة أخرى لم تفهم بالشكل المطلوب أنواع المواد الموصلة والعازلة للكهرباء ، فيمكن إعطاء كل مجموعة بالإضافة إلى الواجب المنزلي الاعتيادي -الذي يطلب من كل التلاميذ واجب إضافي يركز على نواحي الضعف كأن يعطى التلميذ مقالة تشرح تكوين الدائرة الكهربائية عليها بعض الأسئلة والتطبيقات لذلك هذا النوع من التقويم يفرضه المعلم على التلميذ بناء على التغذية الراجعة التي استمدها من التقويم اليومي حول مستوى تقدم التلاميذ التقويم الذي يرتبط بطول الوحدة الزمني والذي غالبا يمتد لأسبوعين أو أكثر يتضمن نوعين من التقويم ، الأول يهدف إلى إعطاء التلميذ فرصة لاختيار مشروع من بين عدة مشاريع يناسب قدراته وميوله ويمكنه من استخدام مهارات عقلية مركبة تحتاج عادة إلى فترة طويلة نسبيا لكي يتقنها النوع الثاني وهو غالبا ما يطبق في الصف أو المعمل يهدف إلى إعطاء تغذية راجعة لكل من المعلم والتلاميذ حول مستوى أداءهم في الوحدة أما النوع الأخير من التقويم المرتبط بالوقت والذي يمتد لفترة طويلة قد تكون نصف فصلية أو فصلية فهو محفظة التقويم.

كل الأنواع التي سبق الحديث عنها قد تكون مألوفة لكل من المعلم والتلميذ على حد سواء أو قد تكون مدمجة مع أسلوب التدريس حيث لا يلمس بوجودها التلاميذ في بعض الأحيان، ماعدا نوعين وهما المشروع ومحفظة التقويم، لذلك سوف يتم إعطاء نبذه مختصره عن كل نوع.

المشروع project:

التلاميذ داخل الصف الدراسي بينهم تباين واضح في القدرات والاتجاهات هذه الفروق الفردية بين التلاميذ يجب أن تؤخذ بعين الاعتبار كعامل مؤثر في تعلمهم أساليب التدريس الاعتيادية داخل الصف لا يمكن أن تفي بمتطلبات هذه الفروق الفردية إضافة إلى ذلك أصبح من الواضح للمعلمين ولغيرهم ممن له اهتمام بالتعليم أن التلاميذ يملكون قدرات تفوق بكثير ما يتاح لهم استخدامه فعليا في الصف لذلك فان الحاجة إلى بيئة تعليمية جديدة تراعي الفروق الفردية بين التلاميذ أصبحت حاجة ملحة للرفع من مستوى تعلم التلاميذ واستغلال قدراتهم الفعلية (Chard, 2001) .

كل من البحث العلمي والتطوير التربوي أديا أخيرا إلى استحداث أساليب تدريسية جديدة صممت لأخذ الصف لبيئة تعليمية أكثر استجابة إلى التباين في الحاجات التعليمية والاهتمامات بين التلاميذ المشروع احد هذه الأساليب الذي يقدم مدى واسع من فرص التعلم التي تراعي الفروق الفردية بين التلاميذ وربطها بالصف (Chard, 2001).

المشروع عبارة عن استقصاء متعمق لموضوع فعلي يعايشه التلاميذ في واقع حياتهم ، يمكن أن ينفذ بشكل فردي أو جماعي(Chard,2001) المشروع يتسم بقدرته على استمالة التلاميذ وتشجيعهم على العمل لارتباطه بالحياة الواقعية خارج المدرسة وإعطاءهم الفرصة لعمل أول بحث في العلوم وعرضه بطرائق مختلفة (Chard,2001).

تقويم المشروع يعنى تقويم قدرات التلميذ في موقف حقيقي في نطاق بيئته الفعلية وبما أن التقويم قد يمتد فترة طويلة نسبيا (عدة أسابيع) فانه يشابه بدرجة كبيرة التحديات التي يواجهها التلميذ في واقع حياته (Miami Museum of Science[MMS], 2001) إضافة إلى ذلك فان تقويم المشروع سوف يزود التلاميذ بممارسة المهارات التي تحتاج عادة إلى فترة زمنية لإتقانها مما لا يتسع الوقت لممارستها في الصف كالابتكارية Creativity ، و مهارات التخطيط، و مهارات التقصي والاستكشاف، وتوظيف المعرفة في نواحي تطبيقية(MMS) .

محفظة التقويم Portfolio:

تعرف ماربي (1999) Mabry محفظة التقويم بأنه عبارة عن محفظة أو سجل ينتقي ويضع فيه التلميذ بعض أعماله بهدف إعطاء فكره عامة عن مستوى تحصيله أما Arter and Spandel (as cited in William & Robert,1999,Al-Dosery,2000) فيصف محفظة التقويم بأنها انتقاء هادف لأعمال التلميذ التي يحكي جهوده وتقدمه ومستوى تحصيله في مجال دراسي معين ، ينبني على مشاركة التلميذ الايجابية الفاعلة في اختيار ما يتم تجميعه ووجود قواعد للاختيار ومعايير للحكم على جدارة العمل .

وقد استخدمت محفظة التقويم في العلوم كما استخدمت في مواد أخرى ، وكانت مفيدة بشكل كبير مع الأساليب الحديثة للتدريس التي تتبنى مفاهيم النظرية البنائية كما استمدت أهمية خاصة من ميل التلميذ إلى حفظ أعماله والعودة إليها من وقت لآخر والتفكير في كيفية تطوير عمله في المستقبل) Sweet,1993) .

استخدمت محفظة التقويم بشكل واسع للتقويم الصفي كما استخدمت للتقويم النهائي بغرض الترفيع من صف إلى آخر، و شكلت مكون أساسي في برامج التقويم في العديد من المؤسسات التربوية في بعض الولايات الأمريكية كولاية فيرمنتVermont و كنتاكيKentucky وولاية نيوجرسي New Jersey كما طبقت بشكل تكاملي مع استراتيجيات أخرى للتقويم البديل في معظم الدول وخاصة المتقدمة منها ككندا وبريطانيا واستراليا وغيرها من الدول على سبيل المثال the North American Division Office of Education [NADOE] (2000) استخدم محفظة التقويم وفق الأهداف التالية:

للتدريس:

توضيح مدى تقدم التلاميذ خلال فترة زمنية معينة.

تزويد المعلم برؤية ذاتية لمستوى تدريسه.

مساعدة المعلمين على تقويم مدى اقترابهم من تحقيق أهداف المادة.

إيجاد حلقة تواصل بين البيت والمدرسة.

تنظيم ملفات لأغراض الترفيع.

للتعلم والتحصيل الدراسي للتلاميذ

التيسير على التلاميذ وتحفيزهم على التعلم

توعية التلاميذ وتحميلهم مسؤولية تعلمهم .

تنمية مهارة التفكير النقدي لدى التلاميذ من خلال التأمل والتفكير الذاتي في مستوى أعمالهم.

تعزيز التقدير الذاتي من خلال عرض التلميذ لأفضل أعماله.

مساعدة التلاميذ على تقويم وتثمين أعمالهم.

تقديم أدلة ملموسة لإثبات مستوى إنجاز التلاميذ.

توفير الفرصة للتلاميذ لتنمية مهارات التحليل والتفكير وحل المشكلات

للتواصل

تقوية التواصل بين التلاميذ والمعلمين وكذلك أولياء الأمور.

تقديم أدلة عيانية لأعمال التلاميذ ومستويات تحصيلهم.

إعطاء رؤية واضحة لكيفية تحقيق التلاميذ لأهداف المنهج.

6-2 دليل استخدام برنامج التقويم المعتمد على الأداء

برنامج التقويم المعتمد على الأداء يتضمن موضوعات مادة العلوم للنصف الأول من الفصل الدراسي الثاني، حيث يشتمل على الوحدات التالية الكهرباء، المغناطيس والعلوم في خدمة الإنسان محتوى هذه الوحدات أعيد صياغته ليتم تدريسه وفق أسلوب حل المشكلات problem-solving والأسلوب الاستكشافي inquiry وتعلمه وفق المدخل البنائي constructivist approach مع مراعاة الوقت المحدد والأهداف العامة لكل وحدة هذا التعديل كان أساسيا لاستخدام استراتيجيات التقويم المعتمد على الأداء التي تتطلب القيام بعمليات عقلية عليا يصعب تطبيقها مع أساليب التعلم التقليدي الذي يعتمد على الحفظ والاسترجاع

يتكون البرنامج بشكل أساسي من ستة عناصر (انظر الشكل 6- 2)، وفيما يلي نبذه مختصره عن كل عناصر البرنامج وكيفية تطبيقها:

شكل (6- 2)

الاختبار القبلي البعدي:

يستخدم عادة في بداية تدريس الوحدة وعند نهاياتها، نتائج هذا الاختبار قد تعطيك مؤشر مبدئي عن خلفية التلاميذ في موضوعات الوحدة و يتوقع منك أن تأخذ ذلك بعين الاعتبار عن تخطيط تدريس الوحدة الاختبار البعدي سوف يزودك بمؤشرات عن تقدم التلاميذ ونواحي الضعف في تحصيلهم التي قد تتطلب إعادة تناولها في حصص مراجعة الوحدة أو إعطاءهم مزيد من الواجب المنزلي إذا لم يكن الوقت كافيا مع متابعة التلاميذ ذوي التحصيل المنخفض وإشراك الأسرة قدر الإمكان .

الأنشطة :

كل الأنشطة يفترض أن يقوم بها التلميذ داخل الصف مع مراعاة جوانب السلامة في كافة مراحل النشاط بعكس أساليب التدريس التقليدي ، سوف يكون دورك في النشاط الصفي مساعدا أو مدربا للتلاميذ ، توجه التلاميذ دون أن تقدم لهم إجابة مباشرة لتساؤلاتهم التلاميذ يمكن أن يعملوا بشكل منفرد أو في

مجموعات، على كل حال كافة الأنشطة التي تم إعدادها يمكن أداءها بشكل جماعي لما لهذا الطريقة من فوائد سبق الحديث عنها – ثم بعد ذلك يعمل كل تلميذ بشكل منفرد كل نشاط يحتوي على نسختين إحداهما للتلميذ وأخرى للمعلم

نسخة التلميذ تحتوي على

معايير التقويم:

هي المعايير التي يقوم على أساسها عمل التلميذ وقد أرفقت مع نسخة التلميذ ليتعرف على الأسس التي سوف يقوم عليها أداءه كل نشاط يهدف إلى أن يتعلم التلاميذ بعض الكفايات لعناصر (التعلم الفعال) وسوف تكون أهداف موضوع النشاط هي المحتوى الذي يتم من خلاله اكتساب تلك الكفايات معايير التقويم تشتمل على محددات لتقويم عمل التلميذ بناء على استجاباته وكذلك بناء على ملاحظاتك على أدائه أثناء قيامه بالنشاط معايير التقويم قد لا تحتوى على كل الجوانب المهمة لسلوك التلميذ المتعلقة بالجوانب الوجدانية كالاتجاهات نحو المادة والدافعية وغيرها وان كانت اشتملت على بعض منها لذلك فان استخدام سجل الملاحظة قد يعمل بشكل تكاملي مع معايير التقويم لأخذ تصور كامل عن كل الجوانب المتعلقة بالتلميذ .

نموذج التقويم الذاتي:

التقويم الذاتي جزء أساسي من أي نشاط يقوم به التلميذ، ولكن التلاميذ يفتقرون إلى معرفة أهميته كما تنقصهم المهارات اللازمة للقيام به لذلك من المتوقع أن تعطي هذا الموضوع أهمية خاصة وبالذات في المراحل الأولى لاستخدام هذا الأسلوب، مستخدما في ذلك مختلف الأساليب كأن تبين لهم أهميته في زيادة تحصيلهم، حثهم ومتابعتهم على إكمال نموذج التقويم الذاتي تدوين بعض الملاحظات في خانة الملاحظات في معايير التقويم تشير فيها إلى تقويم التلميذ لذاته ، وكذلك مناقشة التلميذ في ذلك سوف تجد في الأنشطة الأولى نماذج مبسطة للتقويم الذاتي لتتدرج بعد ذلك في محتواها لتناسب تلاميذ الصف السادس الابتدائي.

نسخة المعلم تحتوى على أهداف النشاط، وصف النشاط وطريقة إجراءه

الواجب المنزلي :

تم إعداد الواجب المنزلي ليحقق الأهداف التالية:

دعم التدريس والكتاب المقرر.

تزويد التلميذ ببعض المعلومات حول المفاهيم العلمية ذات العلاقة.

ترسيخ فهم التلميذ بإعطائه مزيد من التطبيقات لما تم تعلمه في الصف.

تغطية بعض الجوانب المهمة للدرس التي لم يتم تناولها في الصف.

مساعدة التلاميذ ذوي التحصيل المنخفض بإعطائهم مزيد من المعارف والتطبيقات.

تحتوى الواجبات المنزلية على مقطع صغير حول موضوع معين مع بعض الأسئلة التي تتدرج في صعوبتها لتناسب القدرات المختلفة للتلاميذ.

المشاريع:

تشتمل كل وحدة على عدد من المشاريع ، بحيث يختار التلميذ المشروع الذي يلائم قدراته واتجاهاته سوف يعمل التلميذ على المشروع لفترة من 2- 3 أسابيع بناء على طول الوحدة يجب متابعة التلميذ خلال عمله على المشروع للتأكد من اعتماده على نفسه و توجيهه إذا احتاج إلى مساعدة

العرض:

يفترض أن يقدم كل تلميذ عمله في النشاط السابق (المشروع) أمام زملائه ولكن لعدم وجود الوقت الكافي لكل التلاميذ في كل وحدة، ينصح بإعطاء الفرصة لأكبر عدد ممكن من التلاميذ في كل وحدة أيضا يمكن إعطاء التلاميذ فرصة تقديم العروض داخل المجموعة ، باختيار تلميذ من كل مجموعة لتقديم نتائج عمل مجموعته مثل هذا الإجراء قد يكون مفيدا لتدريب التلاميذ على التقديم أمام الصف ولكن قد يكون مفيد بشكل خاص للتلاميذ الذين يعانون من الرهاب الاجتماعي تقويم أداء التلميذ يجب أن يتم بناء على معايير التقويّم التي يفترض أن يزود التلميذ بنسخه منها قبل وبعد التقديم

المهام:

تعطى المهام في نهاية تدريس الوحدة لتقويم مستوى تحصيل التلاميذ لموضوعات الوحدة مع أنه من الممكن أن تؤدى في مجموعات، يفضل أن يقوم كل تلميذ بأدائها منفردا إذا توفرت الأدوات اللازمة ومع أن إجراءات تطبيقها مشابهه لإجراءات تطبيق النشاط، إلا انه ينبغي أن تكون إجراءاتها أكثر صرامة ودقة وسوف تجد أن معايير التقويم تركز بشكل كبير على المعارف والمهارات

محفظة تقويم التلميذ

محفظة التقويم تعتبر نسبيا من أدوات التقويم الحديثة، لذلك ينبغي تقديمها للتلاميذ وتشجيعهم على استخدامها وفيما يلي بعض المقترحات التي يمكن أن تساعدك على تقديم محفظة التقويم للتلاميذ بشكل ناجح:

قدم محفظة تقويم للتلاميذ على أنها من الأدوات التي يستخدمها عادة الأشخاص الناجحون الذين يحتفظون بأعمالهم في ملفات كالعلماء والأدباء وغيرهم .

شجع التلاميذ على اختيار بعض أعمالهم لوضعها في المحفظة وناقش معهم سبب اختيارهم لتلك الأعمال.

ضع خطة توضح من خلالها للتلاميذ معايير اختيار أعمالهم التي يمكن إدراجها في السجل وعددها وكيفية تقويمها.

تابع باستمرار عمل التلاميذ على هذه المحفظة وكيفية تطويرها والمحافظة عليها.

8- الألعاب

أحد أهداف تطبيق هذا البرنامج، تعزيز اتجاهات التلاميذ نحو مادة العلوم، لذلك فان كل العناصر السابقة صممت في صيغ مشوقة للتلاميذ إضافة إلى ذلك تم اختيار بعض برامج الألعاب التعليمية المرتبطة بالوحدات المختارة ليمارسها التلميذ في أوقات فراغه داخل المكتبة

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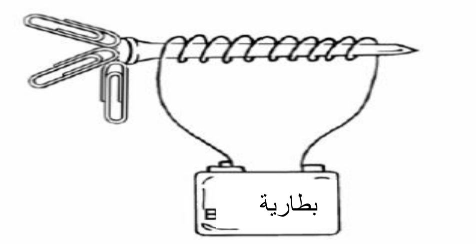
اختبار مادة العلوم للصف السادس الابتدائي

اسم الطالب. . . . . .المدرسة . . . .

فيما يلي مجموعة من الاسئلة ولكل منها إجابة واحدة صحيحة والمطلوب منك وضع دائرة حول رمز الإجابة الصحيحة لكل سؤال :

- 1 أي من أنواع الكهرباء التالية تمر عبر الأسلاك لإنارة المصباح:
  - أ. الكهرباء الساكنة
  - ب. الكهرباء الناشئة من البرق
  - ج. الكهرباء الثابتة
  - د. التيار الكهربائي

2-الطاقة التى استخدمت لمغنطة المسمار لجذب مساكات الورق كما ترى في الشكل التالي هي الطاقة :



- أ. الحرارية
- ب. الكهربائية
- ج. الكيميائية
- د. الضوئية

- 3 أي من مجموعات المواد التالية يمكن استخدامها لإضاءة المصباح:
  - أ. كأس مساكة ورق مصاصة عصير
  - ب. بطارية جافة سلك معدني مصباح
  - ج. مصباح بطارية جافة – فيش
  - د. بطارية جافة قطعة بلاستك مصباح

4-صنف المواد التالية إلى موصلة وعازلة للكهرباء قطعة من الخشب ، قطعة من النحاس ، سكينة بلاستك، بالون، مسمار من الألمنيوم، شوكة من الحديد، أنبوب من المطاط ، سلك نحاسي، ساق من الحديد.

موصلة	عازلة

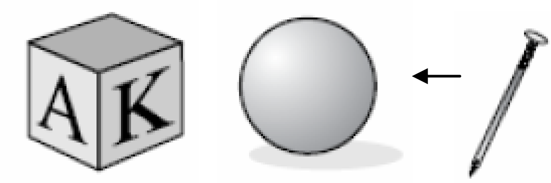
5- الشيء الذي لا يحتوي على مغناطيس ، هو :
- أ. شريط الكاسيت
- ب. التليفزيون
- ج. الراديو
- د. دباسة الورق

- 6 من صور الكهرباء الساكنة
أ. المطر
ب. المد البحري
ج. البرق
د. البركان

7- إذا قُرب جسمين من بعضهما بعد شحنهما بشحنة متشابهة، فإنهما:
أ. يتنافران
ب. يتجاذبان
ج. يلتصقان ببعضهم
د. لا يحدث لهما شيء

- 8 المادة التى تنجذب إلى المغناطيس ، هي:
أ. الفضة
ب. الرصاص
ج. الماء
د. الحديد

- 9 في الشكل التالي انجذب المسمار (أ)نحو الجسم (ب) بينما المكعب الخشبي (ج) لم يتحرك



أ ب ج

الطاقة التي جعلت المسمار ينجذب إلى الجسم (ب)، هي الطاقة
أ. الضوئية
ب. الحرارية
ج. الكهربائية
د. المغناطيسية

10-يحتوي كل من الشكلين التاليين (أ ،ب) على مغناطيسين

S ج Nش	N ش Sج

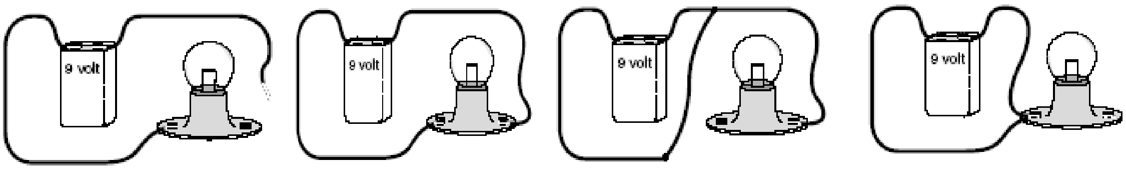
شكل (أ)

Sج N ش	S ج Nش

شكل (ب)

ماذا يحدث عند تقريب المغناطيسين من بعضهما في كل شكل؟
أ. يتجاذبان في الشكل (أ) و يتنافران في الشكل (ب)
ب. يتنافران في الشكل (أ) و يتجاذبان في الشكل (ب)
ج. يتجاذبان في كل من الشكلين (أ ، ب)
د. يتنافران في كل من الشكلين (أ ، ب)

11 في أي من الدوائر الكهربائية التالية سوف يضيء المصباح؟



أ ب جـ د

12-يستخدم المفتاح (القاطع) ، لـ:

أ. فتح أو إغلاق الدائرة الكهربائية

ب. فتح الدائرة الكهربائية

ج. توصيل الدائرة الكهربائية

د. قطع الدائرة الكهربائية

13 الإبرة المغناطيسية للبوصلة تتجه دائما نحو:

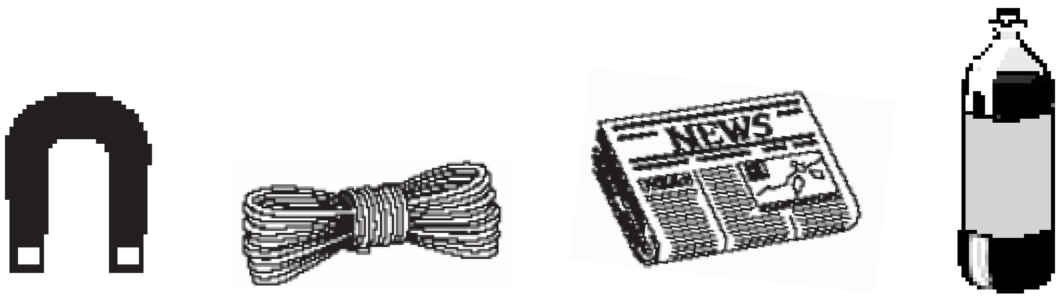
أ. اقرب مغناطيس منها

ب. الغرب

ج. الشرق

د. الشمال

14 أي من المواد التالية يؤثر على اتجاه إبرة البوصلة :



-أ علبة بلاستك ب- صحيفة ج-. حبل د- مغناطيس

15-عند كسر مغناطيس إلى قطعتين فان:

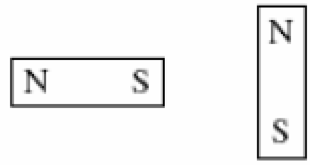
أ. كل قطعة تحتفظ بنصف الطاقة المغناطيسية

ب. يكون لإحدى القطعتين قطب جنوبي وللآخر قطب شمالي

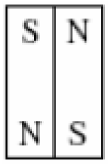
ج. يكون لكل قطعة قطبين شمالي وجنوبي

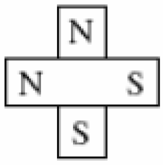
د. تفقد كل قطعة الطاقة المغناطيسية

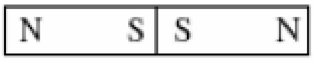
-16 الشكل التالي يوضح قضيبين من المغناطيس

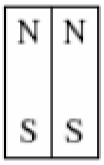


أي من الأشكال التالية يمكن أن ينشأ عن تقريب المغناطيسين من بعضهما









أ ب جـ د

-17 يمكن توليد الكهرباء الساكنة عن طريق:

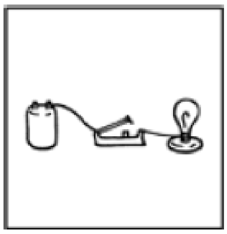
أ. ربط جسمين ببعضهما

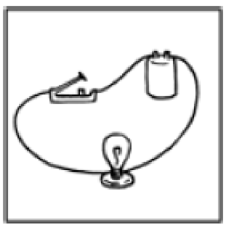
ب. تقريب جسمين من بعضهما

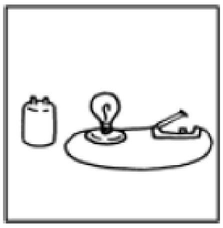
ج. دلك جسمين ببعضهما

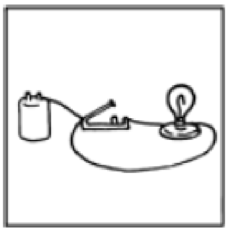
د. لصق جسمين ببعضهما

-18 في أي من الدوائر الكهربائية التالية سوف يضيء المصباح عندما يغلق المفتاح؟



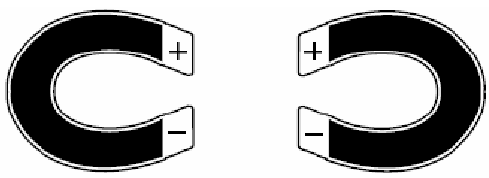






أ ب جـ د

-19 عند وضع مغناطيسين أمام بعضهما على طاولة كما في الشكل التالي، فإنهما



أ. ينجذبان لبعضهما

ب. يتنافران من بعضهما

ج. لن يكون هناك أي قوة مغناطيسية بينهما

د. القوة المغناطيسية سوف تغير اتجاه المغناطيسين

20 عند إضافة أكثر من بطارية بدائرة كهربائية تحتوى على مصباح واحد ، فإن إضاءة المصباح سوف:

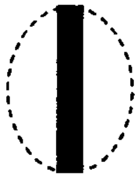
أ. تضعف

ب. تقوى

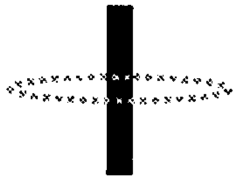
ج. تتلاشى

د. لن يحدث لها أي تغيير

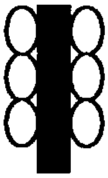
21- أي من الأشكال التالية يمثل مجالا مغناطيسيا؟



أ



ب



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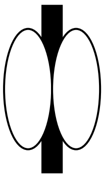


د

22- يستخدم المغناطيس في:

أ. المولد الكهربائي

ب. المدفأة الكهربائية

ج. المصباح الكهربائي

د. لاشيء مما ذكر

23- قوة المغناطيس :

أ. تتوزع بالتساوي بين أجزائه

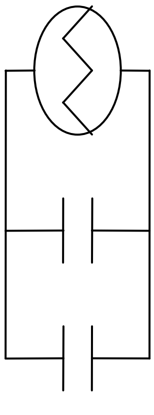
ب. تتركز في قطبيه

ج. تزداد في الوسط

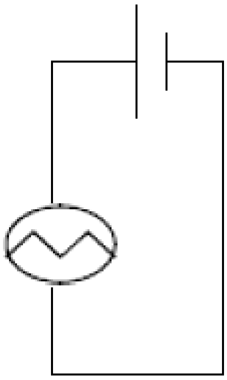
د. تتجمع في أحد أقطابه

24- تم ترميز الشكل رقم (1) في عدة أشكال أدناه أي منها يعتبر الترميز الصحيح؟

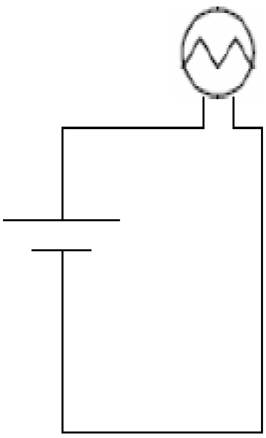
شكل رقم (1)



أ



ب



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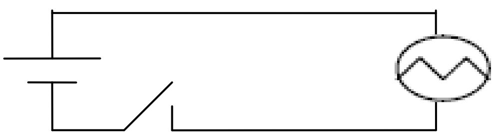

د

مقياس الكفايات الأساسية للتقويم الأدائي

يتضمن المقياس التالي عدد من الأسئلة لكل منها إجابة واحدة صحيحة ، اقرأ كل سؤال بعناية ثم اختر الإجابة الصحيحة بوضع دائرة على رقم الفقرة

	المفردات
1	من أهم العوامل التي دفعت بالتربويين إلى البحث عن تقويم بديل، كون أساليب التقويم التقليدية أ. لا تعكس المخرجات التعليمية التي يركز عليها المعلمون في الصف . ب. تعطي معلومات جزئية مقارنة بما يعرفه التلاميذ أو قادرين على أداءه ج. تقود إلى نظرة ضيقة إلى المنهج د. تركز على قياس مستويات دنيا من القدرات ه. كل ما سبق
	تركز الاتجاهات الحديثة للتقويم على : أ. قياس المهارات المركبة ب. التقويم الفردي ج. قياس المهارات و الحقائق المجردة د. كل ما سبق
	يتسم التقويم المعتمد على الأداء بـ: أ. درجة عالية من الثبات ب. تمثيله لمواقف واقعية للتقويم ج. سهولة تصحيحه د. كل ما سبق
4	يتطلب التقويم المعتمد على الأداء من التلاميذ: أ. تذكر معلومات محدده من المعارف حول موضوع معين ب. استخدم عمليات عقلية عليا ج. اختيار استجابة صحيحة من بين عدد من الخيارات المطروحة
6	محفظة التقويم هي: أ. عبارة عن سجل ينتقي ويضع فيه التلميذ بعض أعماله بهدف إعطاء فكره عامة عن مستوى تحصيله. ب. سجل التقويم البديل الذي يقوم على إشراك الأسرة في عملية التقويم ج. سجل لكل أعمال التلاميذ يحتفظ به المعلم لأغراض التقويم النهائي د. لا شيء مما ذكر
7	قواعد التقويم الكلّي احد أساليب الحكم على مستوى أداء التلاميذ بناء على: أ. درجة التلميذ على التمرين أو النشاط بشكل عام ب. الدرجة التحليلية المفصلة لكل جانب من جوانب التمرين ج. الدرجة الكلية للتلميذ على عدد من الأنشطة أو المهام د. كل ما سبق

8	المكونات الأساسية للتقويم المعتمد على الأداء، هي: أ. مهمة الأداء، قواعد الأداء، ورقة الإجابة ب. مهمة الأداء، مفتاح الإجابة، ورقة الإجابة ج. الأسئلة، قواعد الأداء، ورقة المعلم د. لا شيء مما ذكر
9	باستخدام طريقة التقويم المعتمد على الأداء طلب أحد المعلمين من تلاميذه بعد أن وزعهم على مجموعات أداء النشاط المعروض على السبورة والذي كان عبارة عن مشكلة علمية تتطلب من كل مجموعة مناقشة سبل حلها في نهاية الحصة طلب المعلم من كل طالب أن يتذكر ما قام به أثناء الحصة وتسجيله في ورقة خارجية، المشرف المتابع الذي كان حاضرا الدرس انتقد المعلم لأنه: أ. ترك التلاميذ يناقشون حل النشاط ب. لم يوزع عليهم ورقة الاستجابة ج. لم يطلب من كل مجموعة تقديم نتائجهم للمجموعات الأخرى د. كل ما سبق
10	من الخصائص التي يجب مراعاتها سواء عند تصميم مهمة الأداء أو عند اختيارها، أن: أ. يكون لها فقط إجابة واحده صحيحة ب. تركز على جانب واحد من جوانب التفكير ج. تتطلب استخدام أساليب تفكير مختلفة د. تركز على المعارف التى سبق شرحها
11	ما هو الوقت المناسب لإطلاع التلاميذ على قواعد التقويم: أ. قبل أن يبدأو العمل في المهمة ب. عند الانتهاء من المهمة مباشرة ج. بعد تقويم أعمالهم
14	معلم علوم أراد أن يقيس مدى فهم تلاميذه لوحدة الكائنات الحية فطلب منهم تصنيف بعض الحيوانات إلى مجموعات وعمل روابط منطقية بين تلك المجموعات أي من الطرق التالية يجب أن يستخدم الطلاب؟ أ. الطريقة الاستقصائية ب. طريقة حل المشكلات ج. طريقة خارطة المفاهيم د. لا شيء مما ذكر

15	تمثل الحالات التالية على التوالي ، الأساليب التالية: أ. استقصاء حل مشكلات – استقصاء ب. استقصاء -حل مشكلات – حل مشكلات ج. استقصاء-استقصاء حل مشكلات د. حل مشكلات حل مشكلات استقصاء الحالة الأولى: في حصة العلوم . . يشير إلى كيفية تنمية التلاميذ لمعارفهم ومحاولة زيادة فهمهم للأفكار أو الظاهرة العلمية، وذلك من خلال أنشطة يتعلم منها التلاميذ كيف يقوم العلماء بدراسة الظواهر الطبيعية وكيف يحدث الاتصال فيما بينهم وكيف تتفق آراءهم حول بعض القضايا العلمية كما يتعلمون كيف يقترح العلماء تفسيرات للظواهر الكونية. الحالة الثانية: عبارة عن سلسلة من العمليات المعرفية والمهارات يستخدمها المتعلم للوصول إلى هدف معين عندما يكون ذلك الهدف غير متاح أمامه الحالة الثالثة: استخدام أي من الأدوات التى يعرفها التلميذ بهدف تنفيذ حل للفروض المطروحة
16	أي من التعليمات التالية أكثر اتساقا بمفاهيم النظرية البنائية في التعلم أ. قم بتدريس وسط الصف للحصول على أفضل النتائج ب. تأكد من جاهزية كل طالب وأن لديه الأدوات المناسبة لبدء النشاط ج. توقع أن يتعامل كل طالب مع أدوات النشاط بشكل مختلف لحد ما عن زملائه د. استخدم أساليب التذكر
17	أي من الكلمات التالية يجب أن يصوغ بها المعلم أسئلة بهدف تقويم مهارات تلاميذه في تنظيم المعرفة وأدراك ما بينها من علاقات بدلا من مجرد استحضارها: أ. قارن، وازن بين، انقد ب. حدد، عين، عدد ج. رتب، زاوج ، اختار د. عرف، أذكر، استرجع
18	أراد أحد المشرفين التربويين أثناء تقويم أحد معلمي الصف السادس الابتدائي التعرف على ما إذا كان المعلم يقوم بتشجيع التلاميذ على استخدام عمليات عقلية عليا في الصف أي من الأمور التالية يعد أكثر أهمية في تحقيق هذا الهدف : أ. دفتر تحضير الدروس ب. دليل معلم العلوم ج. نماذج من الاختبارات التي أعدها المعلم د. الأعمال التي قام بها التلاميذ
19	يتسم التقويم الذي يستخدم للرفع من مستوى تعلم التلاميذ ،بأن: أ يكون جزء حيوي من خطة التدريس والتعليم ب-يأخذ بعين الاعتبار دوافع التلاميذ للتعلم جـ-يدرك على أنه عملية محورية للممارسات الصفية للتلاميذ -د كل ما سبق

أي من الخيارات التالية يمكن أن تكون أكثر مصداقية في تقديم معلومات عن أداء التلميذ لتساعد المعلم في اتخاذ قرار ات تتعلق بنجاح التلميذ أو رسوبه في المادة : أ. درجات الاختبارات التى أعدها المعلم لموضوعات المادة والتي تحتوى على ثلاث أسئلة مقالية ترتبط بأهداف تدريس المادة ب. درجات 20 سؤال اختيار من متعدد قام بإعدادها المعلم لقياس أهداف معينة من أهداف تدريس المادة ج. نتائج الإجابات الشفهية للطلاب على الأسئلة التي طرحها المعلم على كل منهم خلال فترة تدريس المادة د. نتائج المتابعة اليومية التي صممت لتشير إلى نوعية المشاركة الصفية للطالب خلال الحصة	20
اتفق عدد من المعلمين على وجوب استخدام أساليب معينة لتقويم أداء تلاميذهم إلا إنهم اختلفوا على أوقات استخدامها أي من الآراء التالية التي اقترحوها يمثل الاختيار الأمثل للتقويم : أ. يجب أن يقوم المعلم أداء تلاميذه قبل الدرس للتعرف على مستوى تلاميذه وبعد الدرس لقياس مدى استيعابهم للشرح ب. يجب استخدام التقويم في كل فترات التعلم مع اختيار الأسلوب المناسب في كل فترة ج. منعا لتشتيت انتباه المعلم يجب أن يقوم مستوى التلاميذ في نهاية الحصة أو عند الانتهاء من تدريس الوحدة. د. لاستغلال وقت الحصة بالشكل المطلوب يجب على المعلم الاعتماد على الواجبات المنزلية لقياس المستوى التحصيلي لتلاميذه	21
أي من العوامل التالية يعتبر تفسيرا غير منطقيا لعدم الاتساق بين درجة التلاميذ في الاختبار النهائي مع نتائج أداءهم في الصف : أ. بعض الطلاب يصابون بحالة رعب في الاختبار النهائي بينما يكون أداءهم جيد في الاختبارات الصفية ب. اختبارات الاختيار من متعدد تقيس فقط استحضار المعلومات، بينما التقويم الصفي يمكن أن يقيس مهارات عقلية عليا ج. التلاميذ غالبا ما يأخذون الاختبارات النهائية على غير محمل الجد د. الاختبارات النهائية ربما لا تمثل مفردات المنهج مقارنة بالاختبارات الصفية	22
أعطى معلم لتلاميذه ثلاثة اختبارات خلال الفصل الدراسي الثاني ويريد أن يعطي لكل اختبار وزن نسبي متساوي عند حساب الدرجة الكلية في نهاية الفصل حيث أن طريقة التقويم تقوم على ترتيب التلاميذ بناء على مستويات تحصيلهم لإحراز هذا الهدف أي من الطرق التالية أقرب لتحقيق التساوي النسبي بين الاختبارات الثلاثة: أ. عدد الأسئلة ب. عدد التلاميذ الذين اخذوا كل اختبار ج. معدل الدرجات د. تباين (مدى) الدرجات	23
يعتمد احد معلمي العلوم لتقويم أداء تلاميذه على الاختبارات و الواجبات المنزلية بينما يتعمد آخر غالبا على ملاحظة أداء تلاميذه في الصف الفرق الأساسي بين هذين النوعين من أساليب التقويم باختصار هو الفرق بين: أ. التقويم الرسمي و العادي ب. التقويم الأدائي والتطبيقي ج. التقويم الفردي والجماعي	24

	د. التقويم النهائي والبنائي
25	طلب أحد المعلمين من تلاميذه تطوير أنموذج للنظام الشمسي كأحد متطلبات تقويم أدائهم في الوحدة أي من إجراءات التقويم التالية أكثر واقعية لتقويم مشاريع التلاميذ: أ. عند استلام مشاريع التلاميذ يعطى أفضل أول مشروع أعلى درجة ثم يعطى المشروع الثاني درجة أقل وهكذا مع بقية المشاريع ب. تصحيح المشاريع بناء على جودتها على مقياس من 5 درجات ج. قبل تسليم المشاريع يمكن بناء مفتاح تصحيح بناء على أهم خصائص المشروع كما سبق تحديدها مسبقا بناء على أعلى مستوى أداء للتلاميذ في الصف د. قبل تسليم مشاريع التلاميذ يمكن إعداد أنموذج أو مخطط توضيحي للخصائص المهمة للمشروع وتوزيع الدرجات بناء على هذه الخصائص.
26	يرغب احد المعلمين في دعم صدق درجات أحد أساليب التقويم التي يريد أن يستخدمها لتقويم مستوى تحصيل تلاميذه في احد الوحدات ما هي أفضل السبل لتحقيق هذا الهدف: أ. أخذ رأي بعض المعلمين حول مدى تغطية هذه الطريقة لما تم تدريسه ب. دمج خطة التدريس مع طريقة التقويم ج. اخذ رأي التلاميذ في الصف عما إذا كان التقويم صادقا د. سؤال أوليا أمور الطلبة عما إذا كان التقويم يعكس الأهداف المطلوبة
27	أي من الطرق التالية أكثر ملاءمة لاستخدام الملاحظة لأغراض التقويم الصفي: أ. جمع معلومات عن السلوك الذي يصعب تقويمه بالطرق الأخرى ب. تسجيل الملاحظات مباشرة أو بعد عملية الملاحظة بفترة قصيرة ج. ملاحظة الطريقة التى يؤدي بها التلاميذ نشاطهم داخل الصف د. كل ما ذك ر
28	التغذية الراجعة التي يزود بها المعلم تلاميذه بعد تصحيح أو مراجعة أعمالهم لها اثر ايجابي أو سلبي على أداء التلاميذ ، أي من العبارات التالية يمكن أن تؤثر بشكل سلبي أكثر من غيرها على أداء التلميذ: أ. الجزء الأخير من عملك غير واضح أعد كتابته بشكل واضح . ب. عمل سيء غير منظم و إجابات غير واضحة وغير مرتبة ج. طالب مهمل وغير جاد د. عمل غير وضح تماما وغير مفهوم
29	يركز التقويم البنائي على: أ. جمع معلومات يمكن استخدامها لتطوير أداء الطالب والمعلم ب. الحصول على معلومات عن مستوى الطالب تستخدم لأغراض النجاح والرسوب ج. جمع معلومات يمكن أن يبنى عليها قرارات تتعلق بمستوى أداء المعلم. د. كل ما ذكر
30	يعد التقويم الذاتي أحد أساليب التقويم الحديث الذي يمكن التلميذ من : أ. اتخاذ القرارات حول ما يجب تعلمه وتقويمه ب. تقويم أداءه في الاختبارات لتحديد ما إذا كان يبقى أو ينتقل من صفه ج. مراقبة تقدمه وتنظيم جهوده وتقدير جودة أعماله د. لاشي مما ذكر
31	أي من الأمور التالية أكثر ملاءمة لجعل التلاميذ أكثر مسئولية تجاه تعلمهم : أ. إلزام الطلاب بإتباع نظام صارم داخل الصف ب. إشعار أولياء الأمور بأي تصرف خاطئ يصدر عن أبنائهم

ج. أعطاء الطلبة الفرصة لتقويم أعمالهم د. إرسال الطلبة الذين يصدر عنهم أفعال غير مسئولة إلى الإدارة ه. لاشيء مما ذكر	
أسلوب التعلم الذي يساعد على زيادة مستوى تحصيل التلميذ و مساعدته على تكوين اتجاهات ايجابية نحو نفسه والآخرين ، هو : أ. الانفرادي ب. التنافسي ج. التعاوني	32

Developed from:
Standards for Teacher Competence in Educational Assessment of Students(1990) Developed by the American Federation of Teachers, National Council on Measurement in Education and National Education Association; (James R. Sanders ,John R. Hills , Anthony J. Nitko, Jack C. Merwin , Marcella Dianda and Jeffrey.
Teacher Assessment literacy Questionnaire (1993), by Barabra S. Plake& James C. Impara, in cooperation with The National Council on Measurement in Education & the W.K. Kellogg Foundation.
Vol. 60, pp. 40):)Educational Leadership .,Chappuis, S., & Stiggins, R. J. (2002). Classroom Assessment for Learning
.Association for Supervision & Curriculum Development

مقياس اتجاهات التلاميذ نحو مادة العلوم

(developed from: TIMSS, 1999; Century, 2002)

الاسم :   :   المدرسة

يحتوى هذا المقياس على عدد من الاسئلة ، أمام كل سؤال عدد من الخيارات ،ضع دائرة على الحرف الذي يتوافق مع رأيك الشخصي مع العلم أنه لا يوجد إجابة صحيحة وأخرى خاطئة لذا لا تستغرق الكثير من التفكير في الإجابة عليها

الفقرة	أوافق بشدة	أوافق	لا أوافق	لا أوافق بشدة
1. يجب أن أعمل بجد في مادة العلوم	أ	ب	جـ	د
2. أحصل على نتائج عالية في مادة العلوم	أ	ب	جـ	د
3. مادة العلوم من المواد الصعبة	أ	ب	جـ	د
4. أشعر بضعف في مادة العلوم	أ	ب	جـ	د
للحصول على نتائج عالية في مادة العلوم احتاج إلى:				
5. قدرات عالية	أ	ب	جـ	د
6. حظ	أ	ب	جـ	د
7. أحب مادة العلوم	أ	ب	جـ	د
8. استمتع بدراسة مادة العلوم	أ	ب	جـ	د
9. دراسة مادة العلوم مملة	أ	ب	جـ	د
10. دراسة مادة العلوم سهلة	أ	ب	جـ	د
11. العلوم مهمة في حياة كل إنسان	أ	ب	جـ	د
12. أحب أن اعمل في المستقبل بوظيفة تستخدم العلوم	أ	ب	جـ	د
13. اشعر بعدم الارتياح لمادة العلوم	أ	ب	جـ	د
14. أحب أن اعمل تجارب في مادة العلوم	أ	ب	جـ	د
15. أحب أن أتعلم قدر ما أستطيع عن العلوم	أ	ب	جـ	د
16. أحب مادة العلوم أكثر من أي وقت مضى	أ	ب	جـ	د
17. أكره القيام بعمل أي نشاط في مادة العلوم	أ	ب	جـ	د
18. حصة العلوم من أفضل الحصص لدي	أ	ب	جـ	د