University-Industry Collaboration in Learning in the Workplace and Community Project Work

C. R. Ozansoy[1], V. Navaratnam[1], S. Venkatesan[1], V. Sarma[1], S. Keating[2], X. Du[3]

[1]School of Engineering and Science, Victoria University, Australia (cagil.ozansoy@vu.edu.au)
[2]Centre for Innovation in Learning & Teaching, Victoria University, Australia
[3] Department of Development and Planning, Aalborg University

Abstract
Learning in the Workplace and Community (LiWC) is becoming a key feature of all programs and courses at Victoria University (VU). From 2010, all VU courses must include learning in a workplace or a community setting. Various approaches to teaching and learning, including field work, clinical placements and industry or community-based projects, fall under the LiWC umbrella. Problem-based learning (PBL) is a student-centred strategy where students work in small groups on the solution of challenging real-life problems and it therefore offers an effective way for implementing LiWC in engineering education. The implications of the LiWC policy for VU's engineering programs is that, starting from 2010, VU will be seeking greater collaboration with its industry and community partners in the development, facilitation and assessment of LiWC projects. The study outlined in this paper was conducted to explore matters related to the collaboration of academics and industry professionals in engineering education. The specific focus was on the investigation of issues relevant to the collaborative development, facilitation and assessment of LiWC projects. But, more specifically, the paper aims to address the question "What role should industry partners play in LiWC project work".

The research approach used was the use of an online questionnaire to collect both quantitative and qualitative data from industry professionals in regards to a range of issues relating to the use of industry/community projects in the curriculum. The findings will be used to inform the development of partnerships with industry and community partners in VU's project-driven engineering education programs.

Keywords: collaboration, engineering education, industry, community, projects

1. INTRODUCTION

In today's dynamic world, the new demands and challenges presented to engineers have resulted in a shift towards an engineering profession where technical competence is still relevant but equally important are the 'non-technical' competencies used when confronting problems in the ever-changing and multi-disciplinary setting of today's global environment. This has resulted in the adoption of innovative teaching and learning (T&L) approaches at universities all around the world. Accreditation bodies such as Engineers Australia encourage such an approach in their accreditation requirements and competency standards [1]. Furthermore, governments continue to emphasise accountability in higher education and funding allocation is increasingly linked to the demonstration of quality in education [2].

The changes and demands presented to engineers in today's dynamic world has prompted Victoria University (VU) to adopt a new approach to T&L since 2006, when problem-based learning (PBL) was introduced in conjunction with traditional methods for the delivery of University's undergraduate engineering programs. From 2010, VU will be implementing a new Learning in the Workplace and Community (LiWC) policy, which refers to the practice of students engaging in learning in a workplace or a community setting. The LiWC policy mandates that, from 2010, 25% of every student's learning and assessment program will involve learning in and through the workplace and community [3-5]. This challenging requirement requires significant research and planning to achieve successful implementation. Industry and community partners are key players in this new approach. Thus, a key issue for enquiry is the roles and responsibilities that industry and community professionals might play in the design of the courses, facilitation of the projects and the assessment of student learning.

The higher education literature includes many similar approaches, such as Industry Based Learning (IBL), where the boundaries between industry and university partners are ill-defined [6]. The present study was conducted to improve our understanding of the experiences, needs and expectations of industry and community partners. The findings will help to guide how LiWC projects are developed, facilitated and assessed at VU. This paper endeavours to identify the roles and responsibilities that are appropriate and acceptable to industry and community professionals in relation to facilitation, assessment and administration of LiWC projects at VU.

It is well known that assessment is at the heart of student experience [7] and effective facilitation is also important in projects involving external industry and community partners. To ensure the attainment of planned learning outcomes, assessment and facilitation must be clearly aligned in accordance with the principles of constructive alignment [8]. This is easier to implement in the design and delivery of course/units that involve only university staff and students [9]. However, if external bodies such as industry and community partners are to be involved in course/unit design and delivery, it is important to get their perceptions as well. Based on a review of the relevant literature, online questionnaires were developed for each of the key stakeholders: industry/community partners, academics and students. These were then administered to the different groups and responses collected and analysed. This paper mainly presents the analysis of the responses received from industry/community professionals.

2. PROBLEM BASED LEARNING

Effective student learning can be best achieved using well designed and organised activities that put the spotlight on learning rather than the transmission of information. The use of student-centred approaches that focus on the needs of the students and where students are made responsible for their own learning is the key to success. The ultimate goal of any teacher should be to try to foster in the students a desire to expand their knowledge and skills while guiding them through a set of well designed and appropriate teaching and learning activities that form the framework for the learning process. Teaching cannot be limited to helping students develop their technical knowledge and skills but also to assist them in developing work and career related generic attributes. PBL as defined by Norman and Schmidt [10] is a collection of carefully constructed but slightly ambiguous problems presented to groups of students to foster their critical thinking and information seeking abilities as well as their creativity [11]. It is a student-centred strategy where students work in small groups on the solution of challenging problems related to real life situations. It has been demonstrated to be a successful approach, not least because it puts the spotlight on learning rather than the transmission of information.

PBL creates an environment in which students can develop/improve their communications skills by interacting with other team members, working on various written deliverables and taking part in oral presentations. It is widely accepted that the ability to acquire, integrate and apply relevant information while working on problems to arrive at suitable and innovative solutions can be best achieved in a small group setting. It emphasises active self-directed learning rather the passive learning approach encouraged by the lecture format [12]. The use of PBL not only allows students to put theory into practice but also can enable them to comprehend real-life workplace situations. The use of industry and community projects can be significant in getting students to work on and learn about real world engineering problems, design tasks or issues. The presentation of PBL problems as a simulation of professional practice or real-life workplace situations allows students to focus critically on projects that require solutions to the current and future problems faced by the community. This enables them to develop skills and experience valued by future employers. In addition, PBL projects with industry and community partners strengthen the University's capacity to work collaboratively with enterprises and community agencies in its region, an important outcome when universities are being encouraged to engage more effectively with their local communities.

3. PBL AND LIWC AT VU

VU has taken the innovative step of requiring the use of the LiWC approach for the delivery of all its undergraduate programs from 2010. Whilst PBL at VU has been limited to the delivery of undergraduate courses in engineering, VU's LiWC policy [3], which "refers to the practice of students engaging in learning in a workplace or a community setting" [3-4], is to be implemented in all courses across the institution. This presents a substantial challenge to those teaching many courses, but the adoption of PBL in engineering courses has prepared us well for this new transition. However, it requires a framework around which engineering academics "explicitly utilize work and community as an element of curriculum" [3] leading to the design, facilitation and assessment of industry and community based projects in collaboration with industry and community partners.

The implications of the LiWC policy for VU's engineering programs is that, starting from 2010, VU will be seeking greater collaboration with its industry and community partners in the development, facilitation and assessment of LiWC projects [3-5]. There are numerous settings in which LiWC could be implemented. These include, but are not limited to, industry work placements, internships, and on-campus execution of projects for a workplace or community enterprise. The latter is of high relevance to all engineering courses at VU, and is a fairly well established practice already [5]. Before PBL was introduced, Year 4 students often undertook projects of this sort as their final year project. However, the introduction of PBL significantly stimulated this process and to begin with encouraged the broader implementation of such a practice from Year 2 onwards. One of the key attributes of PBL is its feature of being a student-centered strategy where students work in small groups on the solution of challenging problems related to real life situations. PBL is therefore highly compatible with the use of industry/community projects as an element of curriculum, and therefore with the LiWC model. The assessment methods set out in the LiWC policy [3] are consistent with the formative and summative methods already used in PBL, namely team project reports, individual reflective journals or diaries, practical demonstrations and oral presentations or defences. In the past, students used to work on such projects individually. Now, PBL has created an environment in which students can work on such projects in a small group setting developing/improving their communications skills by interacting with each other and by working on various written deliverables, and taking part in oral presentations. This has improved the outcome of the projects as by working in such a group setting, students have improved their ability to collaboratively acquire, integrate and apply relevant information to problems arriving at suitable and innovative solutions with potential for implementation in a real life setting.

The engineering courses at VU are currently being redeveloped to meet a number of institutional requirements, including those of the VU LiWC policy. This has resulted in a common structure for all undergraduate engineering programs known as the VU PBL Engineering model. It includes a common first year and the inclusion of industry/community projects as an element of curriculum from Year 2 onwards. The redevelopment process has presented an exceptional opportunity to embed LiWC in the PBL courses and to develop consistent approaches for these projects. Currently at VU, assessment and facilitation are mainly carried out by the staff, with industry partners playing a relatively minor but crucial role in LiWC projects. Thus, strengthening the involvement of industry and community partners is a major issue. According to the well-known constructive alignment model [8], planned learning outcomes, assessment tasks, and teaching and learning approaches must be aligned. In LiWC projects, the role of industry and the community may just be to provide projects and not to participate in facilitation or assessment. In such cases, constructive alignment cannot be guaranteed. If the new units of study are to be consistent with the requirements of the LiWC policy, the role of industry and community partners must change. There are no clear guidelines how this might be achieved and the current project was designed to inform the development of such guidelines.

4. GOOD PRACTICE IN LIWC

As noted before, today's industries expect engineering graduates to be job-ready when they graduate. The students during their time in higher education institutes gain the theoretical knowledge that is required for their profession, without much exposure to applying the knowledge gained in practice situations. Industry expects engineering graduates to acquire several attributes, during their course of studies, which are required in the everyday work of an engineer. Graduate attributes are defined in [13] as: *'…the qualities, skills and understandings a university community agrees its students would desirably develop during their time at the institution and, consequently, shape the contribution they are able to make to their profession and as a citizen'*. [14]. These attributes include abilities in the use of advanced technologies introduced/used in the industries, leadership skills, ability to communicate well in all levels and in a multicultural setting, ability to perform in a team setting as well as alone, design and project management skills.

Most of the above attributes are not achievable purely from the courses that are traditionally taught in universities. These attributes are best learned when students have a chance to get involved in industry projects on site. Many institutions around the world have introduced learning in workplace as a way to help their students become job-ready when they graduate [15]. Industry Based Learning (IBL), Work Integrated Learning (WIL), Work Based Learning, Workplace Learning, Cooperative Education and Collaborative Education are different terms used for this type of education [5]. In order to achieve good results for learning in the workplace, strong collaboration of industry partners with universities is required. Such collaboration should include using experienced engineers from industry partners to deliver lecturers on relevant topics, to help develop curricula and to provide access to students working on projects [16]. It is also desirable that the industry partners get involved in the assessment of student work.

A number of Australian universities have LiWC/ IBL programs. Some of the established programs are outlined below.

Monash University has an IBL program in their Information Technology courses [17]. Students are engaged in full-time work in the participating companies/industries for 22 or 44 weeks during their second year and third year of studies. Bachelor of Business Information Systems degree students are involved in a 44 weeks IBL program and Bachelor of Computer Science, Bachelor of Information Technology and Systems, and Bachelor of Software Engineering courses include 22 weeks of IBL.

La Trobe University offers an IBL program to students enrolled in their Information Technology courses run in the Bendigo campus [18]. This program is run as two units IBL A and IBL B. Students enrol in both units concurrently. IBL A unit is a prerequisite to enrol in IBL B. Each unit is run over a 20 week period. The programs are formulated by an academic coordinator at the university for students based on their individual circumstances. The supervision of the student is the responsibility of the industry partner. The IBL coordinator monitors the progress of student learning on a weekly basis and assesses the student as follows:

- Preliminary short report, containing industry contact details of the student and the supervisor and a short description of the work that is to be undertaken by the student (5%).
- Reflective diary submitted at the end of each week with details of the tasks carried out, problems faced and how solved, learning outcomes and a brief plan for the following week (25%).
- Mid-semester presentation (10%).

Students are also expected to participate in a range of activities. These include a presentation to first and second year students about IBL, a workshop to prospective IBL students, a presentation to a secondary school or TAFE group, a written report (40%), a final presentation at the end of semester (20%).

Deakin University offers IBL programs in their Science and Technology courses [19]. The industry placement or IBL is offered as an elective subject and runs over a period of 3 to 12 months on full-time, part-time and hybrid modes. The credits assigned to the IBL unit correspond to the length of placement. Assessment of the IBL placements includes a performance evaluation by the industry supervisor mid way through and at the end of the placement as well as a continuous performance management component that is supervised by the Faculty. Students are also required to make a presentation about their placement to prospective IBL students and the Faculty.

Swinburne University of Technology has provided IBL as part of all engineering courses since 1963 [19]. IBL is a unit offered in the year prior to the final year of the course. Students enrolling in the IBL unit are charged a fee of $3000 for a 12 month period and $1500 for 6 month period. It is claimed that the students enrolling in this unit gain valuable workplace experience relevant to the field of study, get exposed to real working environments technically and personally and get an opportunity to look into real problems, associate with other staff and adapt to the work times and routines [20].

The key aspects that need to be addressed in implementing successful LiWC or IBL programs include identifying suitable industry/community partners and engaging them in the program, selecting proper projects for students with different backgrounds and capabilities, team formation, developing appropriate curriculum to suit changing career needs in the industries, encouraging industry experts to actively participate in teaching, project supervision/facilitation and assessment. Identifying suitable industry/community partners to participate in the IBL programs and encouraging them to collaborate in the LiWC program can be a difficult and lengthy process. For example, Swinburne University of Technology IBL units were compulsory between 1963 and 1990. During the recession in the early 90s, they had difficulty involving partners in these programs and hence the units were made optional [20].

It is preferable to have collaboration with industry/community partners on a long-term basis than on a one-off basis and this requires ongoing commitment [5]. In a national aerospace engineering education program in Taiwan three separate offices were set up to coordinate, monitor progress and resourcing of IBL programs [21]. A similar unit within the School of Engineering and Science at VU would enhance the viability and success of IBL programs. At VU, a university-level LiWC unit is already in existence under leadership of the Associate Director for Learning for Work. Ideally, the university expects the industry/community partner to fully commit in the development of its graduates. The expectation is that, rather than just identifying potential projects, the industry/community partner will become more like a mentor to the students, helping them through all phases of the project. This level of support will inevitably vary between industry/community partners based on the level of interest, time and staff availability [15].

The selection of suitable projects is another challenge. The industry/community partner needs to define the scope and expectations of the project so that the university staff member responsible can decide whether it is appropriate in terms of time, money, student skills and course objectives. An unfinished or poorly finished project can result in frustration for both student and the industry/community partner [22], and can result in loss of the partner from the program. Some industry partners may pass on projects in which they don't want to invest their own resources [23]. If such projects are undertaken by students, they may find it difficult to complete the projects on time and to the specifications. Some projects, unless modified with input from university staff, may not be consistent with the learning outcomes of the unit of study. It is therefore necessary for projects to be negotiated by staff of the partner organisation and university staff. This will result in projects that are more likely to be completed by students while achieving the planned learning outcomes of the curriculum.

Curriculum development is undoubtedly one of the critical challenges influencing the success of such a program. Developing a flexible curriculum is important to ensure the students can pursue their academic interests while developing in-depth technical knowledge. Input into the development process by industry experts is highly regarded [21].Engineering courses should be structured in a way that students acquire knowledge and skills that are related to current professional practice. Developing suitable programs and providing ongoing support to students requires identifying appropriate industry or community projects that suit the discipline and the year level of the student and providing facilitation and support throughout the project. This needs input from both university staff and the industry/community partner, as both need to support the student. Lectures and workshops conducted by industry experts are highly valuable in educating engineering students [21], but a partnership involves more than this. In industry/community projects, as in other teaching and learning approaches, the assessment system is a powerful tool that drives student learning. Assessing project work therefore requires careful attention and the role of the industry/community supervisor in assessment must be considered. In part, this will depend on the willingness of the industry/community partner to perform this role.

5. AIM OF THIS STUDY

The specific focus in this study was on the investigation of issues relevant to the development, facilitation and assessment of LiWC projects in collaboration with industry and community professionals. But, more specifically, the research aimed to address the question “What role should industry/community partners play in LiWC project work”. The main objective in this study was to explore the nature and extent of potential collaborations with relevant industry and community partners in VU’s project-driven engineering education programs. The study sought to identify the perspectives of industry/community professionals in regards to a range of issues relating to industry/community projects. The findings of the study will inform the development of partnerships between VU and its industry/community partners in the new curriculum.

6. METHOD

An online questionnaire was developed, based on a review of the literature on LiWC in engineering education, and a sample of industry and community professionals were invited by email complete the survey. The questionnaire included both closed (Likert-style) questions and open questions. The responses received were then analysed using Microsoft Excel, which was also used to prepare graphical representation of the results obtained. The items included in the questionnaire are set out in Table 1 below. For the closed items (items 1-15), respondents were asked to specify their level of agreement to the statement using a Likert-type scale. For open items (Items 16-19), the respondents were able to enter their comments into a free-form text box. Some of the closed items also allowed respondents to add comments by entering them into a free-form box.

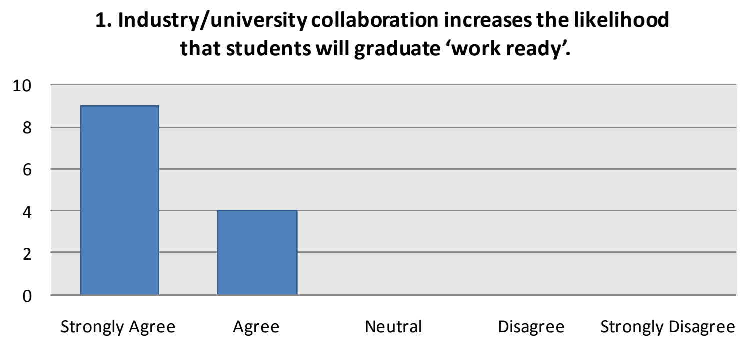
Table 1. Industry Survey Questionnaire

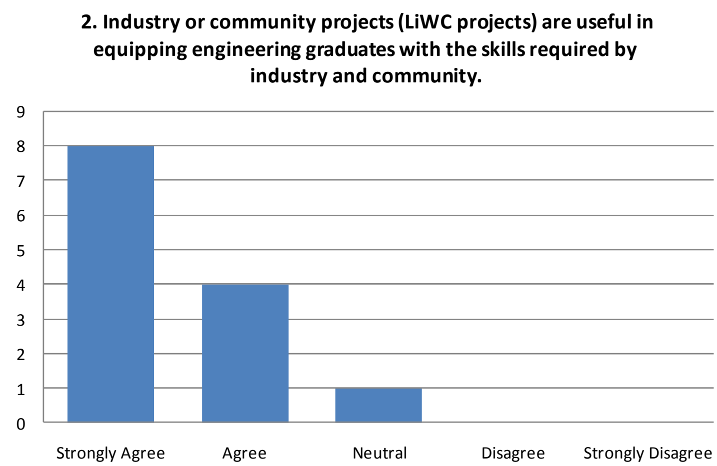
1)	Industry/university collaboration increases the likelihood that students will graduate ‘work ready’.
2)	Industry or community projects (LiWC projects) are useful in equipping engineering graduates with the skills required by industry and community.
3)	We often have projects that would be suitable for groups of engineering students to work on.
4)	We have previously given projects to Universities for engineering students to work on.
5)	The projects completed for us by engineering students could be/have been beneficial to the company
6)	Such projects could provide us with access to potential new employees.
7)	Such projects could provide our own staff with professional development opportunities.
8)	We would expect to be involved in each stage in the LiWC project lifecycle (Formulation of project, supervision and assessment of projects).
9)	We would be prepared to assign a staff member to give guidance to students and feedback on their progress throughout the project.
10)	We would be prepared to meet regularly with the student teams at our workplace.
11)	We would be prepared to help pay (within reason) for the costs associated with execution of the projects where additional equipment and materials are required for a prototype construction.
12)	We would be prepared to contribute to student assessment by providing feedback on the produced deliverables of the project (outputs, oral presentations and/or reports).
13)	We could provide small remunerations to students for their services
14)	Active participation between industry-university increases the likelihood of a successful project.
15)	We would be interested to contribute to curriculum development in this area.
16)	How often would you be prepared to meet with students at your workplace?
17)	If you were supervising students in an industry project, who would you expect to hold the Intellectual Property (IP) rights?
18)	What are your expectations of students and University supervisors?
19)	Do you have any further comments to make about industry and university collaboration?

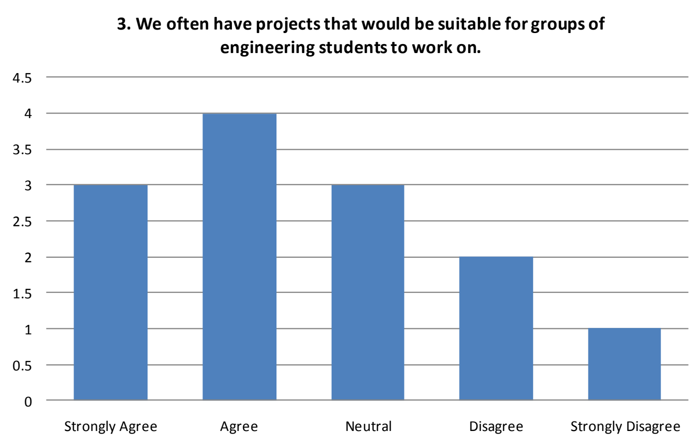
7. FINDINGS

Collecting data from industry and community participants proved to be really challenging. Email invitations were sent to over 200 industry and community participants requesting their participation in the survey. Managers and engineers were mainly targeted when sending the invitations. In spite of the numerous reminders that were sent, only 13 respondents completed the survey, despite the brevity of the questionnaire and assurances that the questionnaire was anonymous and that no information was collected which would have allowed participants to be identified. This very low response rate needs to kept in mind when interpreting the findings, as the findings are unlikely to be representative of the population of industry and community professionals.

As shown in Figure 1, there was a widespread agreement amongst the respondents that industry/university collaboration in engineering education is beneficial to all parties and the use of industry/community projects is useful in helping students develop skills needed in the workplace. However, several respondents (4/13) indicated that they had never collaborated with any university on student projects. Moreover, nearly half (6/13) of the respondents indicated that they either disagreed with or were neutral about the statement 'We often have projects that are suitable for engineering students to work on'. These clearly demonstrate that there are numerous unexplored partnership opportunities that can be looked at by those at VU, and much more needs to be done to demonstrate to the industry that there could always be bits and pieces of their work, which would apply and could be successfully executed by university students.







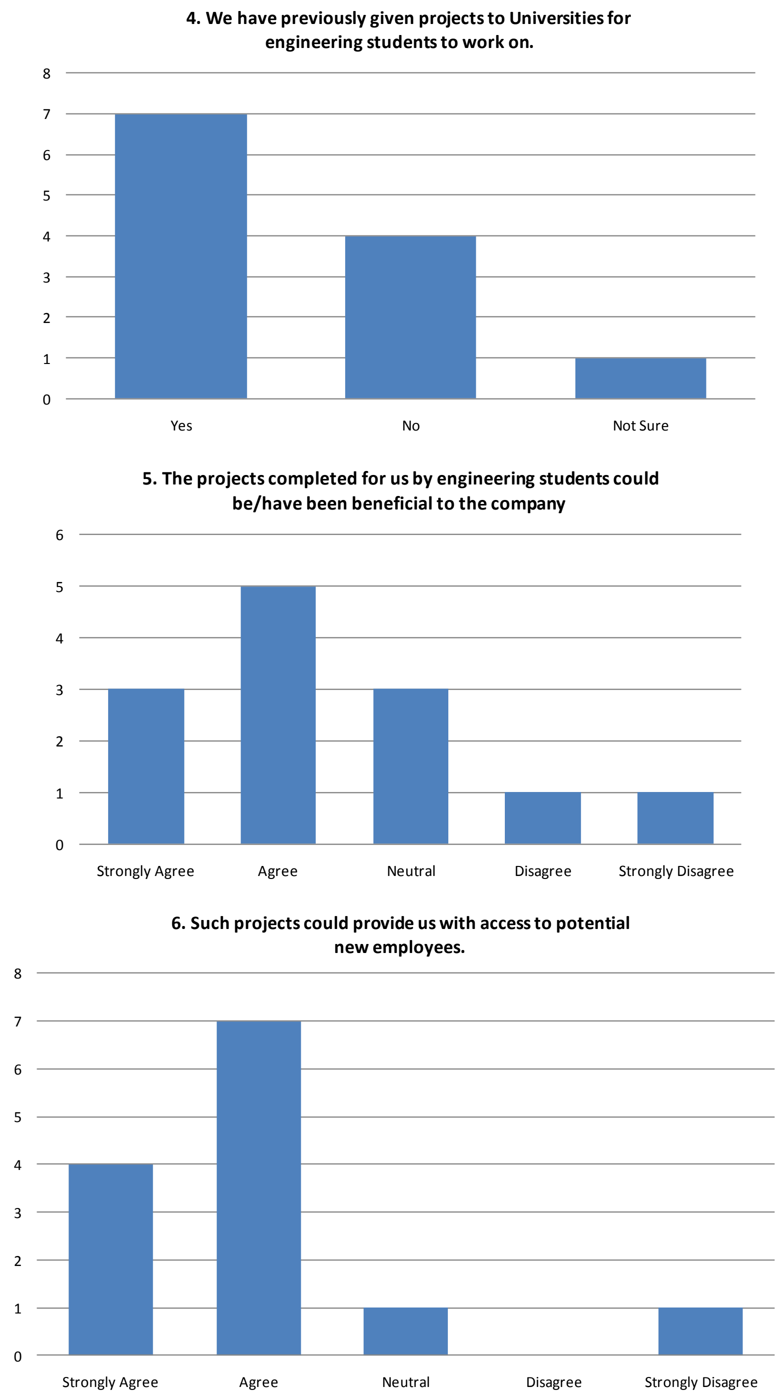


Figure 1: Industry/Community Responses to Questionnaire Items 1-6

The responses to the items shown in Figure 2 suggest that the respondents generally agreed that they should be involved in each stage of the LiWC project lifecycle, including project formulation, supervision and assessment. The responses indicated a willingness in these industry and community representatives to assign staff members to give guidance to students and provide feedback on their progress throughout the project. However, they indicated that they were less willing to meet regularly with the student teams at their workplaces, with 5/13 selecting a 'neutral' response. Nearly half (6/13) indicated that they would pay for the costs associated with execution of the projects, while three respondents disagreed.

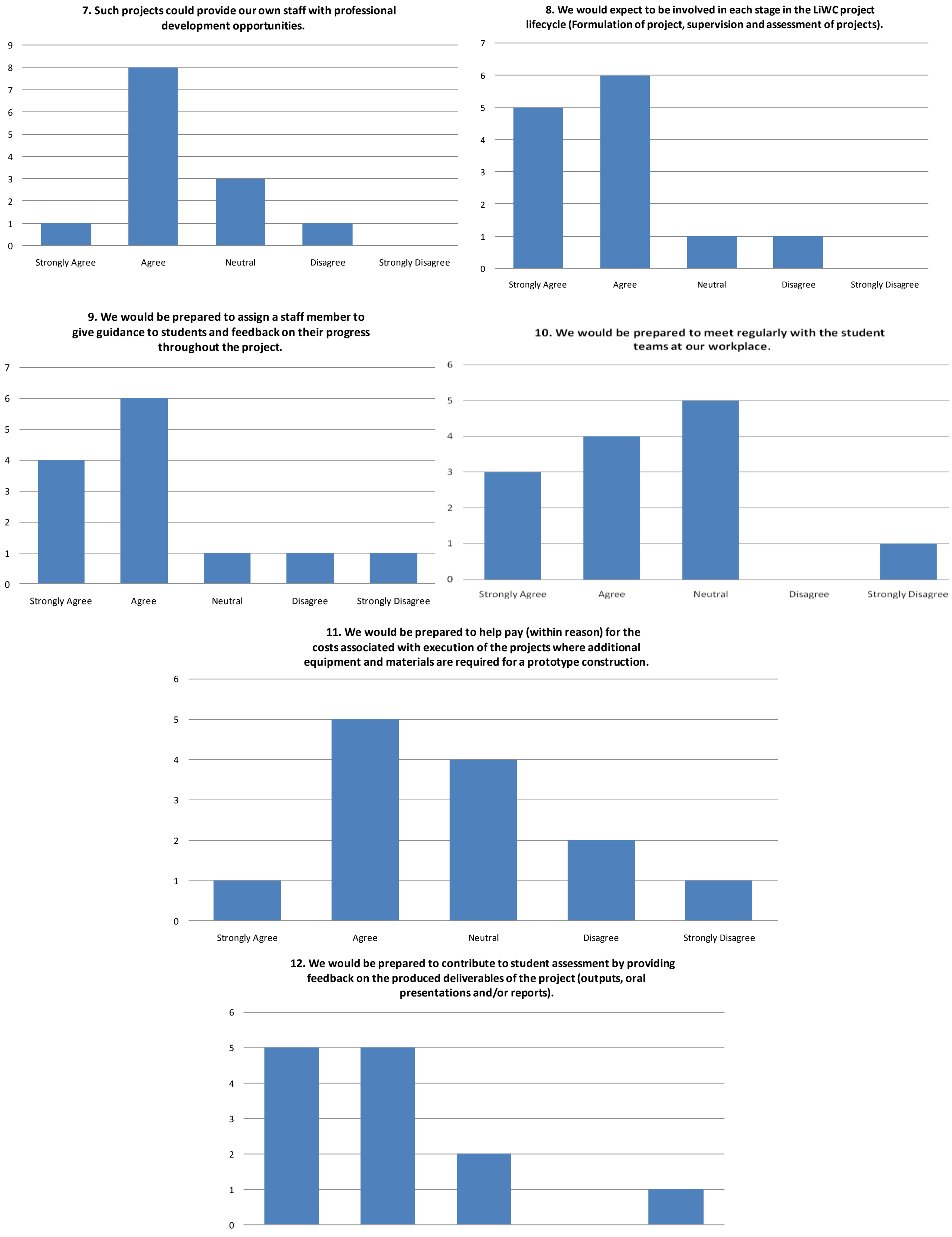


Figure 2: Industry/Community Response the Survey Questions 7-12

In their responses to Items 13-15, respondents indicated enthusiasm for participating in curriculum development and that they were aware that their active participation would increase the likelihood of successful projects. For Items 16 and 17, the closed Likert-style item was followed by an open question that allowed respondents a free-text response. Responses to the question ‘How often would you be prepared to meet with students at your workplace?’ varied considerably, demonstrating mixed sentiments amongst respondents in relation to the desired frequency of meetings with teams of students. In the issue of intellectual property (IP), 9/13 indicated that the company alone should hold the IP rights.

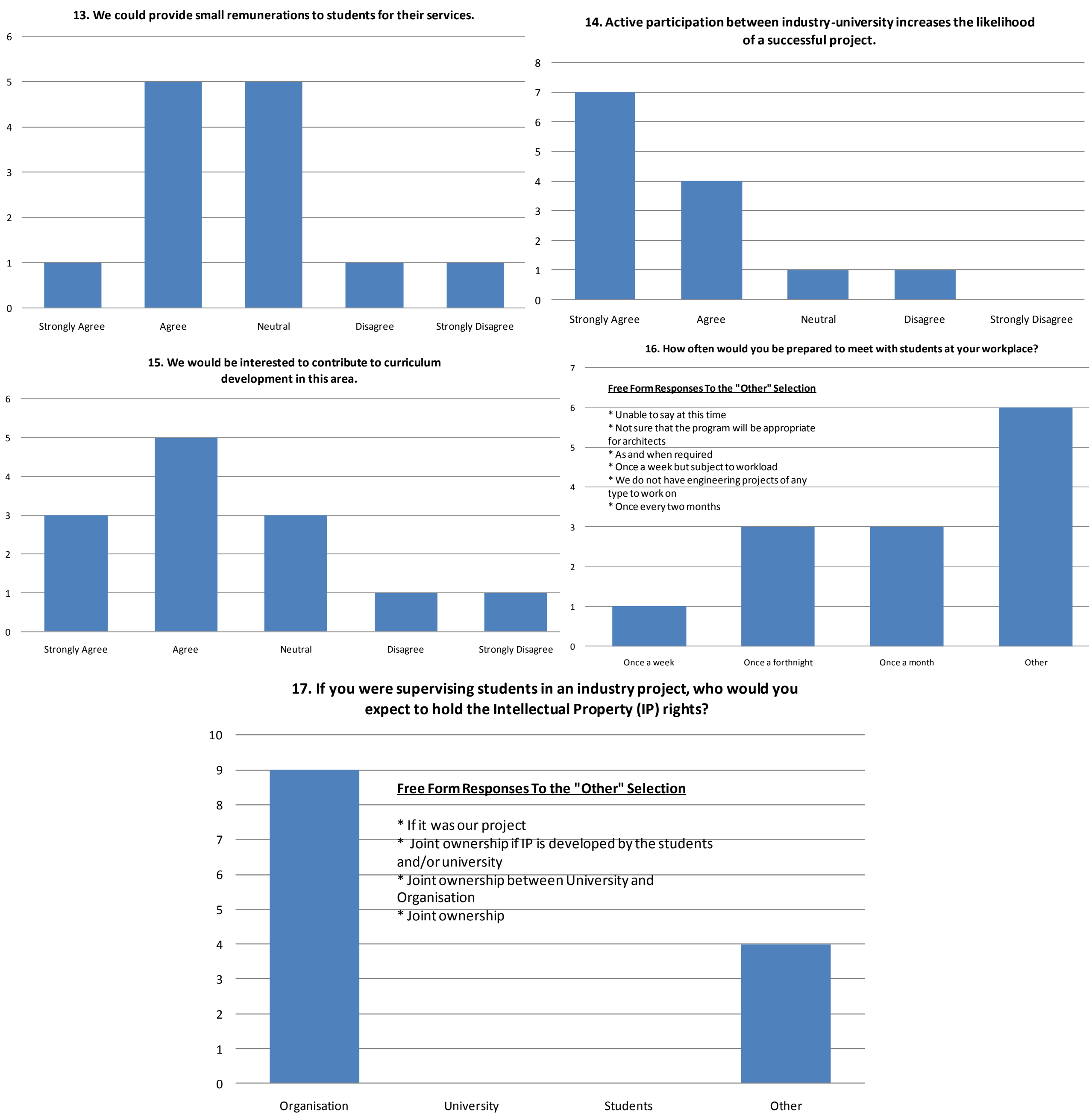


Figure 3: Industry/Community Response the Survey Questions 13-17

Tables 2 and 3 report the comments received from respondents in response to Items 18 and 19 as received without any selection or editing. The respondents clearly indicate that they are looking for committed, creative students, who will genuinely engage in projects.

Table 2. Responses to Item 18

Item 18. What are your expectations of students and university supervisors?	
Response No	Response
1	It works best when there is genuine engagement. As one example we had a group that rarely/never visited us and so produced their project in a vacuum. Their project was well executed but they gained no industry experience, so the main point of the exercise was lost.
2	We only use students in their final year of study so they are able to finally apply some of the theory to practical application. Are university supervisors aware of the day to day realities and functions within an engineering consulting environment i.e. huge workload, tight deadlines, budget constraints, resourcing issues, desk space/PC allocations etc?
3	Work collaboratively Provide enough support to both students and hosting organisation
4	That they come with a basic set of abilities to perform the work agreed upon and that supervisors assist in ensuring the work is performed as agreed. We would expect the work to be done in approximately 3 - 4 times the effort we would assign the work to be done internally. Supervisors should not agree to lessen the agreed deliverables without consulting with the client organisation.
5	Technically competent, positive and enthusiastic attitude, conscious of achieving deadlines and timelines, professional attitude, high level of work quality, willing to learn.
6	Honest discussion & clear goals
7	Commitment, collaboration, creativity.

Table 3. Responses to Item 19

Item 19. Do you have any further comments to make about industry and university collaboration?	
Response No	Response
1	We would need the students to understand that it may not be possible or practicable to implement the solutions they develop. We would make every effort to do so of course
2	It's a great idea in theory, but practically very difficult to follow through with, mainly due to resourcing constraints; reasons are- it would necessitate committing a senior engineer to the programme, taking him/her away from their own workload & deadlines. Our work usually involves significant projects & we would be limited to what type of projects we could pass on for such project work. In addition, we employ 2 - 3 students each year over the 3 month summer break & find having them in-house is far more beneficial. We usually make our placements following this format.
3	It depends on how strongly this collaboration is to mirror real life requirements. We have found a 1 to 10 correlation of real life to student project in terms of the effort expended to produce a simple outcome. And we would have reduced the realism factor down from 10 (real life) to about 4 to ensure a completed project.
4	Projects would need to be carefully tailored to ensure appropriate relationships between industry and university
5	No
6	We're an industry funded organisation & employ university engineering students to work on our own projects there hasn't been as much involvement with university courses
7	This VU commitment has enormous positive potential for our region. Is that potential limited by staff capacity to supervise many large cross-disciplinary studies?

6. CONCLUSIONS

The study outlined in this paper sought to explore the nature and extent of collaborations that can be established with relevant industry and community partners in VU's project-driven engineering programs. Caution is required in drawing conclusions from the findings of the study because of the low response rate to the online survey. The results demonstrate agreement amongst the survey respondents that industry/community/university collaboration in engineering education is beneficial to all parties and the use of industry/community projects is useful in helping students to develop work-related skills. Perhaps the most striking finding was the enthusiasm expressed for getting involved in all of the stages of the project lifecycle (project formulation, supervision/facilitation and assessment). This challenges the assumptions underlying our current practice of minimal involvement of industry/community partners in student projects. However, the results also identified a concern that respondents may be required to commit too much time to meetings with students. This combination of enthusiasm and concern signals clearly that, while there is potential for developing much more substantial partnerships with enterprises and community organisations regarding student projects, such partnerships require effective communication and hard work. This survey represents the start of what must be an ongoing dialogue between VU and its industry/community partners.

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