Examining Climate Change Education within the VCE Curriculum and its Implementation at a Victorian Secondary School

Veerendra Prasad

Bachelor of Education (University of the South Pacific)

Post Graduate Diploma in Climate Change (University of the South Pacific)

Graduate Certificate in Educational Research (Monash University**)**

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Abstract

Climate change (CC) is currently considered to be the most systemic threat to life on Earth. Education plays a critical role in the global CC response. The importance of CC education has been reiterated in most CC international conventions, including Article 12 of the 2015 Paris Climate Change Agreement. To date, only a few studies have been undertaken to examine what the Australian government, states and territories are doing in regard to educating young Australians about CC. In particular, there is a scarcity of research that examines the three critical aspects of CC education: the curriculum, the teaching of CC, and the learning of CC.

This study examines CC education within the Victorian Certificate of Education (VCE) study designs; and, its implementation within a Victorian upper-secondary school. Specifically, the study examines in which VCE subjects CC is taught, its conceptualisation and integration within the subjects. In regard to implementation, the study examines the perspectives of teachers who teach CC in Years 11 and 12, and their students, with particular attention given to the implemented curriculum and the attained curriculum. Specifically, the following research questions were put forward: (1) How is CC represented in the study design for years 11-12 in the VCE curriculum, and how is it conceptualised? (2) How is CC education conceptualised and implemented in years 11-12 from the teachers' perspectives? And, (3) How is CC education conceptualised by Years 11 and 12 students studying the topic?

A qualitative methodological approach is applied to data selection and analysis. Data sources for addressing the first question consists of the study designs constituting the VCE curriculum. Keywords were developed and applied for identifying study designs in which CC is present. These were further analysed thematically. Data sources for addressing Questions 2-3 consist of semi-structured interviews with teachers and students at the selected Victorian school. Thematic analysis is applied for examining CC conceptualisation.

The results indicate that CC education is present in only ten subjects out of the 96 VCE study designs. CC education in the various study designs appears in silos. Within these silos, the content knowledge is fragmented and de-contextualised from the comprehensive aspects that make up CC. The incomplete conceptualisation of CC by the curriculum also extends to teachers and students. The teachers in this study do not seem to have formal structural support for teaching CC. Additionally, the curriculum is not prescriptive enough in relation to CC, and there are no professional development or teamwork opportunities at the school that could potentially support teachers. The students in this study are eager

to learn more and much of their knowledge about CC is derived from the media rather than from school, suggesting that schools are failing to equip students with appropriate CC knowledge.

The study contributes applicable and translational information that may be used to improve CC education within Australian schools in general, and at the Victorian VCE level in particular. The critical deficits found in the conceptualisation of CC and integration within the curriculum should be of prime interest to policymakers, curriculum developers and educators. There is an acute need to provide teachers with appropriate CC pedagogical content knowledge and support in teaching CC at the school level.

Key Words: Climate change education, intended curriculum, implemented curriculum, attained curriculum, multidisciplinary education, cross-disciplinary education.

Declaration

I, Veerendra Prasad, declare that the Master by Research thesis entitled ‘Examining Climate Change Education within the VCE Curriculum and its Implementation at a Victorian Secondary School’ is no more than 60,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, 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.

I have conducted my research in alignment with the Australian Code for the Responsible Conduct of Research and Victoria University’s Higher Degree by Research Policy and Procedures.

Signed: 

Date: 16/ 03/ 2021

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List of Acronyms

4CA	Child-Centred Climate Change Adaptation’
ACE Assembly	Alliance for Climate Education Assembly’
AGNAPES	The Australian Government National National Action Plan for Education for Sustainability
CC	Climate Change
CCESD	CC Education for Sustainable Development
COP	Conference of the Parties
CRP	Climate Reality Project
ESD	Education for Sustainable Development
FEE	Foundation for Environmental Education
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GHG	Greenhouse gases
GREEEN	Green Environment Education European Network
IPCC	Intergovernmental Panel on Climate Change
LSF	Learning for a Sustainable Future’
NAP	National Action Plan
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
OECD	Organisation for Economic Co-operation and Development
SEAMEO	The Southeast Asian Ministers of Education Organisation (SEAMEO)
SPC	Secretariat of the Pacific Community (SPC)
TTPCC	Teachers’ Training Program on Climate Change’ (TTPCC
UNACC	United Nations Alliance of Climate Change: Education, training and public awareness
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
VCAA	Victorian Curriculum and Assessment Authority
VCCF	Victoria’s Climate Change Framework
VCE	Victorian Certificate of Education

Chapter 1
Introduction

1. Introducing the study

This study addresses CC curriculum development and implementation in upper-secondary schools. Specifically, it examines the scope and conceptualisation of CC in the State of Victoria's curriculum documents, and the ways in which these formal documents are interpreted and enacted in Year 11-12 teaching and learning.

CC is unequivocally regarded as the most severe threat of our time **(**Intergovernmental Panel on Climate Change [IPCC], 2013). The anthropogenic impacts on the environment are altering the natural global climatic patterns, causing irreversible and dangerous changes to all Earth's inhabitants and the viability of its ecosystems (Baptiste, 2016; Karl & Trenberth, 2003; Korsager & Slotta, 2015; IPCC, 2014a; National Aeronautics and Space Administration [NASA], 2021; National Oceanic and Atmospheric Administration [NOAA], 2021).

Various international organisations have realised the importance of educating the public and the young generation in particular, regarding the severity and urgency of the looming crisis. Since the United Nations Framework Convention on Climate Change (UNFCCC, 1992), international documents and treaties have repeatedly been stressing the critical role of education in the global CC response. For example, Article 12 of the Paris Agreement, states that "Parties shall cooperate in taking measures to enhance climate change education, training, public awareness, public participation and public access to information" (Paris Agreement, 2015, Article 12). In 2018, this call was put to practice at COP 24, taking place at Katowice, Poland. A high-level Education Day event brought together ministers of education and the environment, as well as international organisations to discuss the role of education in the implementation of the Paris Agreement (UNFCCC, 2018). A year later, at COP25, in Madrid, the UN Climate Change Executive Secretary, Patricia Espinosa, reiterated the need for CC to be included in school curricula and national climate action plans (UNFCCC, 2020).

These international, as well as regional organisations, such as the OECD (Organisation for Economic Co-operation and Development), while being influential in shaping policies, have no statutory powers in relation to national curricula. From this perspective, they may be regarded as mainly inspirational. However, judging by the urgency, severity and universality of CC, it seems only natural to expect that much research efforts would be directed to examining CC education, curricular frameworks and relevant education policies, with the aim of developing best-practices for

implementation. A review of the literature reveals quite the opposite. There is scarcity in studies addressing nations' CC curriculum policies, development and implementation (Aikens et al., 2016; Læssøea et al., 2013); and most studies related to school CC education tend to focus on teachers, students and pedagogies, often in separation (Boon, 2010; Chang & Pascua, 2016; Dawson, 2015; Dawson & Carson, 2013; Leiserowitz et al., 2011; Sternäng & Lundholm, 2012; Taber & Taylor, 2009). Thus far little attention has been given to examining the interconnected relationships between the three actants: the curriculum, the teachers and the students, in relation to CC education. It is yet unclear how the architectural design of the curriculum may impact the teaching and learning of CC. In Australia in particular, most studies on CC education focus on middle-year students (Dawson 2015; Boon 2010; Boon 2009). Little is known about what is taught and learnt in upper-secondary years. These years are particularly important, as they are the final formative school years prior to students' entry to adult life.

The high importance of CC education and the scarcity of information regarding implementation in Australia in general and particularly in Victoria, form the motivation for the present study. The study puts forward the aim to close these knowledge gaps by examining CC education at the three inter-related levels of curriculum, teaching and learning, in relation to each other. For developing an in-depth understanding regarding the ways in which CC is conceptualised by the upper-secondary curriculum and enacted by teachers and students, the study employs a case study design, focusing on one secondary school in the state of Victoria.

1.1 Aims and Objectives

The aims of the research are to examine the ways in which the Victorian Year 11-12 Curriculum addresses CC and to examine CC education implementation in a Victorian secondary school. Specifically, the study addresses the following research questions:

i) How is CC represented in the study design for years 11-12 in the VCE curriculum, and how is it conceptualised?
ii) How is CC education conceptualised and implemented in years 11-12 from the teachers' perspectives? And,
iii) How is CC education conceptualised by Years 11 and 12 students studying the topic?

In addressing these questions, the following objectives were put forward.

To:

1. Analyse VCE study designs in regard to CC education.
   Specifically, to:

i) Develop criteria for identifying CC topics within the Victorian Curriculum study designs.

ii) Use the developed criteria for identifying the presence of CC education within the VCE study designs of Years 11-12.

iii) Evaluate the conceptualisation of CC education within the study designs.

2. Examine CC conceptualisation and implementation from the teachers' perspectives.

In regard to conceptualisation, examine teachers' perceptions in relation to:

i) the need to teach CC and the role of CC education;

ii) the ways in which CC may best be taught;

iii) their confidence in teaching; and,

iv) their understanding of CC concepts;

In regard to implementation, obtain information related to:

v) CC topics that are being taught;

vi) the integration of CC education in and between disciplines; and,

vii) the implemented pedagogy.

3. Examine CC conceptualisation by Year 11 and 12 students studying the topic.

Specifically examine students' understanding of:

i) CC concepts;

ii) CC as multisystem phenomena;

iii) the impacts of CC in everyday life, on societies and the world and,

iv) the sources of information that inform students' learning of CC.

1.2 Significance

This study has multiple contributions to offer to the small and emerging field of CC education research. The main significance of this study is that as stated above, it is likely to be the first examination of CC education provision at multiple curricular levels, ranging from the formal to the attained curriculum (Van Den Akker, 2004). The study further contributes to developing methods for examining curricula in relation to CC presence. By developing criteria for identifying CC presence in the curriculum, it becomes possible to examine the curriculum from both aspects of CC conceptualisation and the scope of contents.

In regard to the chosen case study, to the best of my knowledge, it is the first time that CC education is examined in the upper-secondary level at the state of Victoria and in Australia, at large. By this, the study provides much-needed knowledge about students' CC knowledge prior to leaving school. Finally, by focusing on one school as a case study, this research provides in-depth

information regarding the pedagogical tools used by teachers when enacting the curriculum. I believe that the findings of this study are useful not only to the education research community but also to curriculum developers, education policymakers and the teachers that are teaching CC in class.

1.3 Outline of chapters

In what follows, Chapter Two provides a review of the relevant literature, exploring CC education. In Chapter Three, the research methodology and the research methods are outlined. Chapter Four reports on the findings of the study. Finally, Chapter Five engages critically with the findings and draws out the main meanings and implications of this study.

Chapter Two
Literature Review

2. Introduction

This chapter reviews a broad range of literature focussing on CC education. To situate this research within the existing literature and provide conceptual parameters from within which the study's research questions can be explored, this literature review is organised under the following themes: International and governmental policies in regard to CC education; the importance of integrating CC in schools' curricula; programs promoting CC education; the conceptualisation of CC education; CC education implementation within schools' curricula; and, teaching and learning CC: Challenges to teaching and limited outcomes.

2.1 International and governmental policies in regard to CC education

The international community has recognised and highlighted the importance of CC education since 1992. Article 6 of the United Nations Framework Convention on Climate Change (UNFCCC) established the necessity of CC action through education, training and public awareness (UNFCCC, 1992). In Article 6, the UNFCCC gives priority to six areas of action: education, public awareness, public participation, public access to information, international cooperation and training, indicating potential dimensions for school-based CC education approaches. Since 1995, continuous annual meetings of the UNFCCC Parties (Conference of the Parties [COP]), are held to review CC progress, including in the area of education, which is an annual reinforcement of the key role education plays in addressing CC.

During COP 20, the ‘Lima Ministerial Declaration on Education and Awareness-Raising’, was adopted by the signatory ministers and heads of delegation. One of the recommendations from this COP was to “encourage the governments to develop education strategies that incorporate the issue of climate change in the curricula” (UNFCCC, 2014, p. 38). Following on from this, the ‘Paris Agreement’ was adopted at COP 21 in 2015, in which the 196 participating countries, including Australia, under Article 12 agreed to develop extensive CC education programs and to encourage public engagement in decision-making (United Nations, 2015). During COP 21, a thematic day was also allocated to CC education, raising awareness of formal and informal education related to CC (UNFCCC, 2021a) indicating the increasing international imperative for CC education.

Aligned with COP recommendations, the United Nations Educational, Scientific and Cultural Organisation (UNESCO) actively encourage CC education as part of its ‘Education for Sustainable Development’ (ESD) program (UNESCO, 2018). Within this ESD program, the specific ‘CC Education for Sustainable Development (CCESD)’ program promotes the implementation of CC education. CCESD targets and supports policymakers, teachers and teacher educators, and curriculum development specialists, to reinforce the scientific, mitigation and adaptation capacities, particularly in countries that are vulnerable to CC risk (UNESCO, 2015). Adaptation is the process of adjusting to impacts, actual and expected, of CC, while mitigation is an act of reducing the sources that contribute to CC (IPCC, 2014b). CCESD provides guidelines for member states to strengthen their CC education initiatives. As a result, various ongoing projects and programs such as ‘Carboschools’ (Europe), ‘Sandwatch’ (UNESCO international program), CC related Education Modules for schools (UNFCCC Education and Training: Resources), to name a few, have emerged. These programs have raised awareness about CC among schools and education networks; enabled practitioners to integrate CC education into curriculum frameworks; and strengthened partnerships and collaboration within the community, in particular with youths and women (UNESCO, 2015).

In 2012, seven of the United Nations organisations collaborated to launch the ‘United Nations Alliance of Climate Change: Education, training and public awareness’ (UNACC) (UNFCCC, 2021b). This Alliance has grown so that UNACC currently comprises thirteen UN organisation members (not including Australia), indicating the increasing attention nations are giving to CC education. The UNACC aims to promote practical, result-oriented and effective international cooperation relating to CC education and to support the implementation of the UNFCCC’s Article 6, calling for the prioritisation of CC education. The UNACC is engaged year-round in organising activities to strengthen collaboration in addressing CC issues through education, training and public awareness (UNFCCC, 2021b). This work is highlighted each year during the COP meetings, in

which UNACC organises special side events, which presents the CC education achievements by the members of the Alliance.

Despite the progress made in raising awareness on the importance of CC education by international organisations, implementing CC education is dependent on the individual country's educational policy and political agreements. The international agreements and alliances have no real regulatory impact and so the local policy and aligned outcomes, as an expression of the international recommendations, varies. Education policy development and implementation is a complex and evolving process involving multiple stakeholders and therefore needs to be well planned (Viennet & Pont, 2017). In Australia, where this research is focused, policies are developed and implemented at both the National as well as State and Territory level, which further complicates the situation. This is due to the governing structure of Australia as a Commonwealth Country, where the federal government has responsibility for making laws for the whole of Australia, while the state and territory governments are responsible for making laws for their state or territory (Parliamentary Education Office [PEO], 2021). Some governing powers are shared between the state and territory parliaments. These powers are said to be concurrent and include aspects of education, health and the environment, to name a few (PEO, 2021). Thus, the educational landscape for CC education in Australia is complex and involves numerous interested parties and stakeholders. This situation adds problems and tensions for CC education curriculum development and implementation.

In 2009, the Australian government indicated the prioritising of sustainability in Australia by publishing a National Action Plan (NAP) entitled 'Living Sustainably: Government's National Action Plan for Education for Sustainability.' The NAP aims to "equip all Australians with the knowledge and skills required to live sustainably" (The Australian Government's National Action Plan for Education for Sustainability [AGNAPES], 2009, p. 4). The NAP outlined four main strategies, which are: (i) "to strengthen the government's leadership role in education for sustainability"; (ii) "reorienting education systems to sustainability' focuses"; (iii) "fostering sustainability in business and industry", and (iv) "harnessing community spirit to act" (AGNAPES, 2009, p. 5). It is important to note that the NAP does not explicitly address CC and it is not mandatory. Additionally, it has not been updated since its publication in 2009, despite the increasing international focus on CC education in the context of sustainability education (UNESCO, 2015). This evident absence of specific attention to the role of CC education within Australia's National Action Plan and educational policy suggests that there is limited prioritisation of CC education in Australia. This is evidently inconsistent with Australia's commitments to the 2015 'Paris Agreement,' which includes the enhancement of CC education. It is also not in line with

other ‘Paris Agreement’ signatories who have already begun to develop national CC education programs (Whitehouse & Colliver, 2019). For example: Italy is one of the pioneer countries to have mandatory coursework focussed on CC education (Orlandi, 2019).

In Australia, CC education seems to be highly susceptible to changes in the political climate, where a change in government may switch on and off CC education. The two key governing parties in Australia are the Australian Labour Party (ALP) and the Coalition of Liberal and National Parties. These two have different priorities regarding CC, which are reflected in policy and actions. For example, in 2011 the governing ALP government set up the Climate Commission to raise awareness and communicate climate science in a way that can be understood by the public. The Commission published a range of studies on CC research, health implications, international actions and renewable energy, as well as conducting public events across Australia (Metcalfe, 2013). However, this Climate Commission was abolished by the next elected Coalition Government in 2013 (Hanna, 2020). The removal of the Climate Commission two years after it was established by the newly elected opposing political party, signals the critical impact that the governing parties have on enhancing or hindering CC education. Australia’s commitment to CC education policy could therefore be seen as erratic and lacking direction.

At the state level, the Victorian Government, in 2016, developed a guiding framework: ‘Victoria’s Climate Change Framework’ (VCCF), a long-term action plan to 2050 (Department of Environment, Land, Water and Planning [DELWP], 2020). The Framework incorporates the new Victorian state ‘Climate Change Act’ (CCA) and the ‘Taking action together on climate change today’ (TAKE2) pledge. The CCA is the cornerstone of the VCCF, planned to propel CC actions across Victoria to 2050 (DELWP, 2020). While the action plan expresses a clear commitment to addressing CC, surprisingly CC education is conspicuous in its absence from CCA and the CC Framework.

Overall, the state and national Australian CC education guidelines and policy outlined above refer to CC education in a general sense only. To date, literature has not revealed any governmental policy at the national or state and territory level in Australia, directing curriculum developers to include CC education within the study designs of school curricula. This is despite international recommendations stressing CC importance, as discussed in the next section of this review.

2.2 The importance of integrating CC in schools’ curricula

There is a wide agreement that schools need to play a major role in equipping students with the knowledge and skills required for meeting the challenges of their time (Dalelo, 2012). CC education is clearly a major challenge of our time and thus requires addressing by school education.

According to UNICEF (2012), children are amongst the most susceptible to the risks imposed by CC; however, they are also influential agents of change. When children are empowered and educated on CC, the vulnerabilities to threats surrounding them and their societies may be reduced (UNICEF, 2012). CC education has clearly been identified as an important dimension in school curricula. How this is enacted, however, varies.

Literature has revealed that moralising and politicising discourses about CC are becoming part of the everyday lives of children and young people in many parts of the world (Uherek & Schupbach, 2008). On the one hand, widespread climate denial is circulating on moral and political grounds, as scientific pieces of evidence are ignored or challenged under post-truth politics (Cutter-Mackenzie & Rousell, 2019). At the same time, children and young people are frequently exposed to catastrophic images of the impacts posed by CC across the internet, social media and movies (Colebrook, 2014). Despite the background discourse of this conflicting CC knowledge presently, the Australian education system barely acknowledges the climate emergency and the environmental crisis (Harvey, 2020). Harvey (2020) further argues that in most parts of the school curriculum, CC knowledge has not been updated. As such, students have minimal opportunities to develop, articulate and express their understandings, fears and imaginations about CC within their locality and societies (Hill, 2006). Once equipped with the knowledge of CC, young people are more likely to see CC as a priority issue and to take action. For example, Greta Thunberg, the now-famous Swedish teenager, in 2018 realised that there was a significant gap between the scientific CC evidence and the political actions taken to curb CC – something she was not learning about at school. Hence, she initiated a solo climate protest through a school strike (Belam et al., 2019; Reid, 2019). Since then, tens of thousands of school and university students have joined forces in more than a dozen countries, in climate strikes that have become regular events (Belam et al., 2019). These demonstrations bring to the forefront the inadequacy of the school's curriculum as a framework for enabling educators and learners to address their ethical issues, by engaging in knowledge mobilisation on environmental challenges (Brennan & Widdop Quinton, 2020).

Dyster (2013) argues that "education is the most powerful tool and can engage people in the debate, prepare them for working with the green economy, and give the definitive science and facts about the biggest issue facing people" (para. 15). Through CC education, schools have an opportunity to teach their students how to analyse a range of facts and to draw their own conclusions (UNFCCC, 2021a). The UNFCCC further emphasises the role of education as essential for empowering citizens to contribute to efforts locally and globally and meeting CC challenges (UNFCCC, 2014). This position underpins the need to integrate CC education into the school curriculum and the discord

evident in Australia that there is no clear governmental policy for CC education inclusion in curricula. However, CC education program models have been provided internationally to guide integrating CC education within the curriculum. The next section explores these models of CC education programs.

2.3 Programs promoting CC education

In various regions of the world, organisations are active in promoting CC education. The programs described below present the broad efforts undertaken worldwide to mobilise schools toward integrating sustainability education within their curriculum. As described below, the majority of the programs address issues related to CC within the learning sequence.

The program 'Eco-Schools' launched by the 'Foundation for Environmental Education' (FEE) in 1994, was developed initially in Europe and has now become worldwide. In 2019 it was reported to involve 59,000 schools in 68 countries (Eco-School, 2019). The program offers an ideal way to foster environmental concern across the school in a way that connects a wide range of curriculum subjects. The topics of the Eco-Schools complement many of the United Nations' 17 Sustainable Development Goals, including CC education (Eco-School, 2019). The program is structured to continuously improve the school's environmental performance, as well as to educate and empower students to make responsible decisions and to take action on sustainability and environmental issues (Eco-School, 2019). For example, in 2015, the member schools of Eco-Schools in Ontario, Canada, organised hundreds of school-wide campaigns and activities regarding CC education and action (EcoSchools Canada, 2020). Following the campaign, the schools reported that CC understanding and actions had significantly improved among the students and teachers compared to the previous years (EcoSchools Canada, 2020). In Australia, this program is operating in association with local programs, including 'Sustainable Schools', and as 'Resource Smart Schools' in Victoria (which is discussed later in this review) (Sustainability Victoria, 2020).

Over the past 20 years, Europe presented a proliferation in CC educational programs. For example, a project entitled 'Kids4Future' was implemented from 2007 to 2010 with the European Commission's support. 'Kids4Future' was developed with the aim of integrating CC education in schools across Europe as an extra-curricular learning program. This was a short-term voluntary project that the schools could participate in. The project partnered with ten European countries and involved more than 600 schools. The platform of the project, 'Rainmaker story', which addresses CC through stories written in various languages, was used in European schools as prescribed resources (Kids4Future, 2010). Across Europe, some 40,000 children, at both primary and

secondary level participated in the program and 90% of teachers rated the learning value of the story as high (Kids4Future, 2010). However, Kids4Future, despite popular approval is not a mandated program in European schools and the use of the Rainmaker story is a voluntary action by the individual teachers.

The ‘Green Environment Education European Network’ (commonly known as ‘GREEEN Network’), is also a short-term voluntary program. It commenced in 2014 and concluded in 2017. The project developed a guide for CC education, aiming to serve educators across Europe as an aid to their CC curriculum implementation. The GREEEN Network also promoted effective integration of CC into school curricula and educational programs by developing resources, training educators and providing support through networking (GREEEN Network, 2014). The Network engaged secondary school students through activities such as forming students’ clubs, running competitions, organising excursions and getting involved in community work through a multidisciplinary approach (GREEEN Network, 2014). As a result, the opportunities for collaboration between students, teachers and schools have become varied and enriched, significantly improving students’ knowledge, understanding and actions in regard to CC. The GREEEN Network has provided a successful CC education model with many European schools continuing to network for CC through the network.

Additionally, projects such as ‘Carboschools’ or ‘eTwinning’ in Europe, place great emphasis on collaboration between teachers, researchers and students. The program Carboschools, which is conducted in collaboration with scientists, provides teacher training and hands-on experiments for students, including climate science (Uherek & Schupbach, 2008). The second program, ‘eTwinning’ develops books and articles which aid educators in addressing CC and promoting environmental consciousness among students, both within and outside of schools (European Commission, 2021).

In the USA, the program ‘Alliance for Climate Education Assembly’ (ACE Assembly) was developed by the Alliance for Climate Education (ACE) (ACE, 2020). The ACE Assembly is an educational and inspirational program on CC available freely to schools across the USA. The ACE Assembly program is carried out as an extra-curricular activity in the participating schools and encourages beyond-the-classroom engagement. Highly qualified young CC educators conduct the program. These educators tell a story about CC, its impacts, and the power that young people have to address the challenges through fast-paced performance (ACE, 2020). Since 2009, two million students have been educated, and more than 4000 student CC leaders were trained by the program (ACE, 2020). A study conducted by Flora et al., (2014) revealed that students demonstrated a 27%

increase in CC knowledge, 38% became involved in CC issues, and the number of students who discussed CC with their families and peers more than doubled. ACE programs have greatly inspired young people to engage more deeply in-school programs, take personal action, and contribute to policy and consumer advocacy (Floral et al., 2014).

In Canada, the program 'EcoLeague' is being operated by 'Learning for a Sustainable Future' (LSF) (LSF, 2020). The EcoLeague program focuses on linking primary and secondary school students with community project's, thus connecting knowledge with action. Currently, over a million students and close to 2000 schools have benefited from the program's sustainability action projects, including CC focused projects (LSF, 2020). The EcoLeague has developed CC resources for grade K-12, to promote a robust, optimistic link with the natural environment and to serve as a sound foundation for growing students' awareness of CC issues (LSF, 2020). This program is implemented at schools as an extra-curricular activity whereby participating schools are supported through funds, resources and professional development for the educators. Analysis of the program's outcomes suggests that while the CC education benefits, the extra-curricular nature of the program may be problematic for some schools and act as a barrier to inclusion in their curriculum. This seems to limit the widespread adoption of CC education within Canadian schools.

In Asia, the 'Child-Centred Climate Change Adaptation' (4CA) program was initiated in 2008 by 'Plan International' (Plan International, 2021). Currently, there are nine countries across Asia actively participating in the 4CA program. The 4CA program enables students and communities to adapt and adjust to actual or expected CC calamities when confronted by impacts posed by CC. The program operates in collaboration with teachers, students, communities and departments of education), with a focus on promoting the training of children and youth as the primary agents of change within their communities. The program includes texts written in an understandable way for school students in the 13–19 age group, as well as worksheets for application in the classrooms. Educators are also trained and equipped with the relevant CC knowledge (Plan International, 2021).

In Australia, a Victorian government initiative, the 'ResourceSmart Schools' program, assists schools to integrate sustainability and take action on CC (Sustainability Victoria, 2020). ResourceSmart Schools is a free program offered by Sustainability Victoria, and any Victorian school can volunteer to become a ResourceSmart School. The program is an action-oriented and is embedded within the school curriculum and daily actions (reducing waste, saving energy and water, promoting biodiversity) (Sustainability Victoria, 2020). A study carried out by Hall et al., (2015) on the effectiveness of the ResourceSmart Schools have shown that it had raised the understanding of

students and teachers in relation to sustainability. However, this program does not address CC directly.

The worldwide programs outlined above demonstrate some commonalities. The first is the voluntary nature of participation. Secondly, they are all framed around networking and support systems between schools and between schools and communities. Lastly, CC education is integrated into the broader topics of sustainability, and it does not constitute a stand-alone program. While CC forms part of these programs, there is a lack of clarity in regard to the aspects of CC taught, the scope of CC topics addressed, and the depth of students' understanding of CC.

While most programs focus on providing students with extra-curricular sustainability education, some programs focus attention on teachers' professional development in CC. Similar to the above programs, teacher CC professional development is operating in many countries across the globe. Some examples are presented in what follows.

Internationally, in 2013, UNESCO developed a teaching resource entitled: 'Climate Change in the Classroom: UNESCO Course for Secondary Teachers on Climate Change Education for Sustainable Development.' This course had been developed with the aim of bringing CC education outside the science classroom to many other subject areas in an attempt to address the complexity and interrelationship of global challenges; taking into consideration the environmental, economic, social and cultural sustainability issues (UNESCO, 2013). This UNESCO course is intended to allow teachers from various subject areas at the secondary level to introduce CC education for sustainable development throughout the curriculum and was designed to be accessed online from anywhere in the world (UNESCO, 2013).

In India, the 'Teachers' Training Program on Climate Change' (TTPCC) was implemented in 2010 by the 'Climate Reality Project' (CRP), aiming to raise awareness among students about CC through their teachers (CRP, 2015). The TTPCC is designed to equip teachers with CC knowledge and teaching strategies that would enhance motivation and confidence in facilitating CC education both inside and outside the classroom. To date, more than 1000 teachers from over 542 schools have been trained across India (CRP, 2015). In a similar vein, in South-East Asia, an international organisation, the 'Southeast Asian Ministers of Education Organisation' (SEAMEO), was established to strengthen education, science and culture. The organisation produced a teachers' guidebook for teaching CC (SEAMO, 2010). The guidebook contains various issues relating to CC and outlines strategies for integrating CC education successfully into formal and non-formal curricula (SEAMO, 2010).

In the Pacific Region, the program entitled ‘Coping with CC in the Pacific Island Region’ (CCCPIR) is implemented by the Secretariat of the Pacific Community (SPC) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. The program set the broad-ranging aims of supporting teachers in implementing CC education and integrating CC education into existing curricula. This is done through collaborations with the education ministries and training institutions within the Pacific region (SPC, 2010).

The diverse CC education programs presented above portray global attempts to fill the gaps in the absence of a systemic approach for CC curricular integration at schools. The extensiveness of non-government organisations involved in providing CC extra-curricular education clearly indicates that school curricula may be lagging behind worldwide (Brennan & Widdop Quinton, 2020; Efrat et al., 2020). The review of the programs also suggests that programs with a strong focus on CC tend to target secondary school students, whereas programs, where CC is subsumed under the topic of sustainability, are a more broad range in terms of their target audience. This may be due to the assumption that older students are more cognitively prepared for dealing with the complexities of CC (Uherek & Schupbach, 2008). To overcome the limitations of extra-circularity, many of the programs create various incentives and support systems, for increasing schools and teachers’ participation. These include the provision of resources, guidance and funds (LSF, 2020; Uherek & Schupbach, 2008). While the literature offers a limited evaluation of the teacher professional development programs in CC, there is some indication that frameworks which combine high-quality curricular materials, effective support for teachers and networking within communities of experts, are successful in attracting teachers to the programs and retaining their interest and participation (Boon, 2010; Namdar, 2018). To further understand CC education implementation, there is a need to go beyond the exploration of programs and frameworks to the examination of CC conceptualisation that will underpin CC curriculum development. This next section explores CC conceptualisation by identifying key characteristics of the field.

2.4 The conceptualisation of CC

As indicated earlier in this review, the nature of CC is sometimes disputed in popular discourse. As a developing science, and a rapidly changing interdisciplinary phenomenon, key characteristics of CC need to underpin CC curriculum development and teacher professional development (Alkaher, 2020). It will be remembered from the Introduction Chapter, that there is a body of knowledge about CC, underpinning and connecting this knowledge are characteristics that are key to CC. In what follows, the key characteristics of CC are identified through the literature. These CC

characteristics include: complexity and multi-, inter- trans-disciplinary, projections uncertainty, and involves action.

CC involves complexity and it is multi-, inter-, and trans-disciplinary with social systems interacting with climatic systems in complex ways (Donner et al., 2009; Ecimovic et al., 2002; Ingwesen et al., 2013). Shepardson et al. (2011) suggest that CC education requires an understanding of the complex multi-system interactions that impact the climate. Oversby (2015) also draws attention to complexity as a core element of CC, noting that "the nature of CC education is such that complexity is at the science core..." (p. 24). CC clearly cannot be explained by natural sciences alone but, requires social science knowledge as well (Olsen et al., 2013). CC, as a multi-system phenomenon not only has various consequences on the environment but, also dramatically affects the socio-economic conditions of humans (Ali, 2018). The interdisciplinary characteristic of CC cuts across the traditional disciplinary boundaries (Oslen et al., 2013). Hadorn et al. (2008) suggest that CC is multi-, inter-, and trans-disciplinary. As such, CC education necessitates knowledge drawn from multiple disciplines such as science, engineering, social sciences, and humanities (Middleton, 2011; Kelly et al., 2015). Caranto and Pitpitunge (2015) further add that, aspects of CC can be integrated or even serve as a central theme in various traditional disciplines. CC is, therefore, one of the few curriculum areas that can be regarded concurrently as multidisciplinary, interdisciplinary and transdisciplinary. According to Choi & Pac (2006), multidisciplinary "draws on knowledge from different disciplines but stays within their boundaries" (p. 351); interdisciplinarity "analyses, synthesises and harmonises links between disciplines into a coordinated and coherent whole" (p. 351); and, transdisciplinary "integrates the natural, social and health sciences in a humanities context, and transcends their traditional boundaries" (p. 351). All three categorisations of disciplinarity within conceptualising CC can be referred to as cross-disciplinary (Choi & Pac 2006, as cited in Eilam et al., 2020).

CC may be characterised by a level of uncertainty associated with CC modelling projections. This uncertainty is apparent in the long-timescale measurements associated with CC science. However, scientific evidence is clear that CC is happening (IPCC, 2013; Nicholls, 2017). An additional layer of uncertainty is derived from the human-induced aspect of CC (IPCC, 2013). Naturally, when considering the future, there is a degree of uncertainty concerning the impacts, their extent, and when and where these will occur (Tye & Altamirano, 2017). The causes of CC are rooted locally, but the consequences are experienced globally (Kevin et al., 2002), adding to the uncertainty dimension of CC. According to Appiotti et al. (2013), the issues and challenges posed by CC will be experienced for decades and centuries to come. Due to the long-term nature of CC, combating

the challenges becomes problematic as it requires intergenerational thinking (Frohlich & Knieling, 2013) and involves political debates, conflicting views and interests (Abtahi et al., 2017). Such societal factors that interact with the ecological and climatic factors implicated in CC mean that CC understandings and predictions have an inbuilt uncertainty element that needs to be acknowledged in conceptualising CC education.

CC integrates a knowledge dimension with an action dimension (Alkaher, 2020; Hamin & Marcucci, 2013). The body of knowledge related to CC does not stand on its own. It inherently involves human actions (Henderson et al., 2017), as both actions and inactions are equally relevant in the phenomenon of CC (Hamin & Marcucci, 2013). The action dimension of CC is highly contested in the public sphere. Politicians have very diverse views concerning CC, especially on the causes and the ways to respond (Todd & O'Brien, 2016). Regardless of the different perceptions regarding CC actions, there is no doubt that human action is implicated in CC and it is a core characteristic of CC.

The above four characteristics pose particular challenges to integrating CC in the curriculum, as discussed in what follows.

2.4.1 CC education curriculum integration

The question of the ways in which CC education needs to be integrated within the curriculum is inherently related to the conceptualisation of CC and the topics to be included. Similar to CC conceptualisation, the literature reveals very limited consideration regarding CC curricular integration. However, a search of the literature reveals some debate regarding CC curricular integration. In particular, it presents three main approaches: (i) Teaching CC as a topic on its own within existing subjects (Gilmore, 2017); (ii) cross-curriculum integration (Middleton, 2011); and, (iii) teaching CC as an extra-curricular activity (Stevenson et al., 2017). These three categories are derived from the limited exemplars in the literature regarding how to integrate CC education. The three different approaches to integrating CC education in the curriculum are detailed in the following sections.

Studies considering the integration of CC as a topic within existing disciplines disagree as to which discipline is most suitable for hosting CC education. The various suggestions include: chemistry (Feierabend et al., 2010); agricultural science (Ikehi et al., 2014); geography (Dalelo, 2012; Chang, 2012); environmental education (Jorgenson et al., 2019; Liarakou et al., 2011); and, science (Brownlee et al., 2012). A strong argument is made that a thorough investigation of the root causes of the greenhouse effect can be achieved through integrating CC in environmental education

curricula (Liarakou et al., 2011). Contrarily, Brownlee et al. (2012) argue that science is the most suitable host, due to the complex science basis underlying CC. Dalelo (2012) suggests a clustering approach, in which CC will be integrated into two subjects, biology and geography, which are perceived as complementing each other in regard to CC.

Boakye (2015) and Cutter-Mackenzie and Rousell (2019) critique this approach, arguing that CC education generates multiple areas of research and practices and as such, may not merely fall into any one of the disciplines. Moreover, Siegner (2018) suggests that CC education requires more than scientific literacy; it needs to incorporate concepts and dynamics across disciplines and in ways that address emotional, social and cultural forces. Many studies seem to support this broad cross-curricular integration approach (Boakye, 2015; Gomes & Panchoo, 2015; Nasha et al., 2018; Weart, 2013). According to this approach, aspects of CC generate room for communication across the disciplinary boundaries (Weart, 2013), and can be taught within and across disciplines such as science, arts and humanities (Gomes & Panchoo 2015). Exchanging knowledge across disciplines is often necessary to better understand the interrelationships of the different aspects and challenges posed by CC (Thompson, 2018). According to Arnold and Crownfield (2017), cross-disciplinary approaches make learning more exciting and compelling, allowing an in-depth understanding of complex subjects such as CC. However, teaching CC as a cross-disciplinary subject poses a traditional subject challenge for teachers (Oversby, 2015). This is because the content knowledge of the discipline overshadows the interdisciplinary characteristics of CC. Subjects such as science and geography are mostly taught separately in most countries. The resources such as textbooks prepared to teach these subjects also adopt this separation and deliver resources related to CC as additional information in each textbook, but rarely in the context of those covered in other textbooks (Uherek & Schüpbach, 2008). The potential to cover the interdisciplinary characteristic of CC also varies considerably, and therefore comprehensive knowledge of CC is rarely achieved (Uherek & Schüpbach, 2008; Whittle et al., 2018). Similarly, Reid (2015) suggests that, when a subject becomes cross-curricular, it has a very low priority in the core subject and is often ignored or taught with less emphasis.

A few studies suggest weaving aspects of CC into extra-curricular activities such as sporting clubs, religious groups, social groups and student entrepreneurial businesses (Australian Psychology Society, 2017; Stevenson et al., 2017; Tatenda, 2016)). According to Stevenson et al. (2017), educational approaches to CC can take the form of constructive social learning, which may create capacity for personal and societal transformational action. Various organisations have developed extra-curricular CC education programs. Examples of such programs were discussed in detail

earlier in the review. Proponents of this approach suggest that an extra-curricular approach greatly enhances teachers and students understanding (Hall et al., 2015), and creates opportunities for students to get involved and act (Papak & Vidulin-Orbanic, 2011). Some studies point out the challenges of implementing CC education as an extra-curricular subject. Dyment and Hill (2015) suggest that students are already 'preloaded' with too much content from their school core subjects and less inclined to engage with conceptual understandings of complex topics such as CC. Moreover, Fredricks (2012) argues that any greater involvement in extra-curricular activities does not necessarily increase benefits but may lead to stress and anxiety with overloading students. Waite et al. (2017) suggest that an extra-curricular approach requires a champion's drive as it involves greater commitment and resources. Thus, teachers will also need to have passion and support from the administrative team to implement and champion an extra-curricular approach (Dillon et al., 2006).

It is important to note that while the review has identified the three above categories of approaches to implementation, no theoretical discussion was found in the literature regarding the best-practice approach. All three approaches seem to lack theoretical foundations, and they appear mostly as ad-hoc pragmatic solutions. Building on this situation of these various approaches to CC curricular integration, the next section continues by exploring pedagogical approaches for CC education implementation within schools' curricula.

2.5 CC education pedagogical implementation within schools' curricula

A fundamental characteristic of CC is its cross-disciplinarity. CC encompasses a large spectrum of disciplines, ranging from the humanities to the sciences. This spectrum is reflected in the pedagogical approaches found in the literature. At the humanities end of the spectrum, there is a strong emphasis on integrating socio-cultural aspects in CC education. UNESCO (2017), for example, highlights the importance of incorporating Indigenous and traditional knowledge in CC education. This aspect also includes inter-generational and intra-generational social and environmental justice. From a pedagogical perspective, the approach can take the form of young students meeting with their communities' elders and discussing their cultural wisdom (UNESCO, 2017). In line with this approach, Lenzen et al. (2002) emphasise the importance of engaging students emotionally with CC issues. CC knowledge, when imparted, should be able to touch the minds and hearts of the learners (Boakye, 2015). Lenzen et al. (2002) suggest that understanding CC requires an emotional understanding of the struggles and challenges which people across the globe encounter due to CC.

At the science end of the spectrum, some studies emphasise experiential and evidence-based approaches. Here the emphasis leans more toward learning the science of CC. This approach may take the form of: excursions, case studies, explorations and analysis of data, interactions with climate scientists and conducting scientific inquiries (Anderson, 2012; Monroe et al., 2019). Proponents of the scientific approach perceive this as a safeguard against misinformation and CC denialism (Jylha, 2017; Oreskes & Conway, 2010; Vainio & Paloniemi, 2011).

A systematic literature review conducted by Monroe et al. (2019) examined effective CC pedagogical implementation strategies. The results reveal two main strategies. The first focuses on personally relevant and meaningful information, and the second focuses on using active and engaging teaching methods. In the first strategy, personal relevancy is addressed by focusing, for example, on the impacts posed by CC to local ecosystems, agriculture and communities, as well as relating CC data to local weather patterns. The engaging pedagogical approaches utilise experiential, action-based learning and cross-disciplinary approaches, integrating subjects such as biology, history, business studies, environmental education and community engagement. The second strategy, using active and engaging teaching methods, recognises experiential, inquiry-based, or constructivist approaches, as effective teaching strategies for CC education. Monroe et al. (2019) reported that the most effective strategy that was found to best enhance students CC knowledge was a one-hour, fast-paced assembly incorporating music and graphics, role-plays and simulations, visual imagery, documentaries, animated educational videos and simple drawings or cartoons relating to CC. The use of inquiry-based activities was found to increase students' conceptual understanding and understanding of the complex character of CC. In an additional approach, educators can use deliberative dialogue as a strategy to help learners better understand their own and others' perceptions and understanding of CC (Monroe et al., 2019). Deliberative dialogue encourages participants to take on a broader perspective by expressing, comparing, and critiquing different ideas and to collaboratively work towards a fair and equitable conclusion about the issue (Sakhuja, 2016). Through discussion, and with support from their teacher, students will be able to identify their own and others' misconceptions about CC that are contradicted by evidence, enabling them to modify their understandings and acknowledge this shift within their mindset (Lombardi et al., 2014; Monroe et al., 2019). Monroe et al. (2019) conclude that across the various pedagogies reviewed, the most effective strategies allow learners to interact, engage, share ideas and as a result, deepen their knowledge.

Similarly, UNESCO recommends taking an active learning approach for CC education (UNESCO, 2009). It states that a "positive, participatory action and solution-centred approaches to education

and learning need to be developed" (UNESCO 2009, p. 1). When considering the concept of a solution-centred approach, Lawson et al. (2018) emphasise the importance of students taking actual steps to implement their proposed solutions. This approach is thought to increase students' motivation (Filho et al., 2010). The concept of action forms one of the CC characteristics discussed above, and therefore, it is important to model this aspect through the learning process (Ledley et al., 2017).

When considering CC pedagogy, specific attention is required in regard to students' well-being. Some CC topics may elicit strong emotional responses, such as fear, anxiety, guilt, or helplessness (Ojala, 2012; Swim et al., 2009). Often the teaching of CC includes an element of urgency and a need for immediate action. Students may get a sense that the action is needed now, or else terrible things will happen. For many students, this message may lead to CC-anxiety (Moser & Dilling, 2004). Taking account of these responses requires educators to be balanced and sensitive in their pedagogical approaches. Scholars suggest that promoting solution-oriented approaches and constructive, positive attitudes may counteract the potential anxiety (Ojala, 2012; Whitehouse, 2017). Cook (2018) emphasises the eliciting of positive emotions, such as hope, empathy, optimism and connecting to people.

It seems that striking the right balance between causing fear and convening the urgency; between focusing on the humanity aspects, versus focusing on the science aspects and between providing correct information versus enabling young people to interact and construct their own understandings, forms the major challenge in teaching CC. The following section explores further the challenges of teaching and learning CC.

2.6 Teaching and learning CC: Challenges to teaching and limited outcomes

Various scholars have argued that teaching CC can be very challenging due to its contentious nature, which is frequently debated in media and political forums (Dawson & Carson, 2013). Effective engagement of students with these debated aspects of CC requires teachers to have sufficient background knowledge to appropriately engage in CC education (Porter et al., 2012). As indicated earlier in this review, there are abundant public misconceptions regarding CC (Bofferding & Kloser, 2014; Chen 2011; Sterman 2011). Addressing these misconceptions should form an important part of the teaching of CC. Students need support in developing the set of cognitive tools (such as the deliberative dialogue mentioned earlier) which will enable them to distinguish between facts and fiction in regard to CC. However, the examination of the literature reveals a range of inhibiting factors that limit teachers' efficacy in addressing this topic.

Studies examining the challenges that teachers face when teaching CC reveal that : (i) teachers lack knowledge about CC (Alkaher, 2020; Boon, 2014; Herman et al., 2015); (ii) teachers have misconceptions and misunderstandings in regard to CC concepts (Alkaher, 2020); (iii) teachers' CC views are very naïve, (Herman et al., 2015); (iv) teachers are unable to establish the connection between the CC issues and the discipline-based subjects in which CC is being integrated (Alkaher, 2020; Feierabend et al., 2010); (v) CC education is perceived as time-consuming since it involves working with other colleagues (Porter et al., 2012); and (vi) teachers' political views influence their approach in teaching CC (Alkaher 2020; Cotton, 2006; Hess, 2004; Stevenson et al., 2017).

The challenges in teaching CC seem to be reflected in studies examining students' CC learning. Studies examining students' understanding of CC reveal that there is: (i) incomplete or incorrect understanding of CC (Boon, 2010; Chang & Pascua, 2016; Dawson & Carson, 2013); (ii) confusion regarding the causes and solutions (Dawson & Carson, 2013; Liarakou et al., 2011); (iii) perception of environmental problems as inevitable (Sternäng & Lundholm, 2012); and, (iv) perception that the improvement of nature depends on economic growth (Sternäng & Lundholm, 2012). Together these findings suggest that both the teaching and the learning of CC are being compromised. These indications from the literature of compromised teaching and learning of CC, taken together with this review's finding regarding inconsistent approaches to CC curriculum, portrays an overall international limited uptake of CC education.

In summary, this review of CC literature found that while the aspirations are high, the challenges to implementation seem equally high. The review began by presenting the high-level CC education aspirations expressed by internationally acclaimed bodies, including the popularised 'Paris Agreement'. As the review progressed from describing the CC rhetoric to discussing its implementation, many gaps were revealed theoretically and practically. From a theoretical perspective, there is a limited literary discussion regarding CC conceptualisation and curricular integration. From a practical perspective, the review reveals that the majority of CC programs reported are extra-curricular. Little is known about the ways in which CC is addressed by national curricula. Similarly, evidence about CC education implementation is mostly anecdotal. Much of the literature in the field is a patchwork of perspectives and examples from different parts of the world.

When considering CC education in Australia, these gaps are most apparent. In particular, scarce knowledge exists regarding CC presence in the Victorian curriculum, and less so, in the upper-secondary curriculum. Similarly, little is known regarding CC education implementation, from both the teaching aspect and the students' learning.

The present study puts forward the aim to address some of these gaps by developing an integrated qualitative analysis of CC education implementation in Years 11-12 (senior years) in the Australian state of Victoria. In particular, the study aims to examine the three levels of CC education implementation: The Years 11-12 curriculum, the secondary teachers, and their students. These three levels of examination correspond with Van Den Akker's (2004) typology, consisting of the *intended curriculum*, the *implemented curriculum* and the *attained curriculum* (further discussed in methodology Chapter). Together, these three actants are crucial for the successful implementation of CC education. By taking an integrative approach to the examination and focusing on one secondary school as a case study, this research aims at drawing important insights regarding the ways in which CC education is enacted in Victoria. In particular, this study focuses on addressing the gaps identified in the literature, namely how CC education is intended and enacted in the VCE curriculum regarding (i) conceptualisation of CC through key characteristics of CC; (ii) conceptualisation of CC through topics; and (iii) the implementation strategies (curricular integration and pedagogies) used. These three focus areas derived from deficits found in the literature are in fact a guide for the framing of this research inquiry. Having established the rationale for this research, the following chapter outlines the methodology used in this study.

Chapter Three
Methodology

3. Introduction

This chapter includes a detailed explanation of the research methodology. The chapter first presents the philosophical assumptions underlying the methodological approach and the research design. It then describes the methods for collecting and analysing the data, the research trustworthiness, and finally, ethical considerations are discussed.

3.1 Methodological Approach

The study stems from a post-positivist paradigm. Post-positivism recognises that observations are not perfect, and all theories can be revisited and challenged (Panhwar et al., 2017). While the approach has an inherent appreciation for the objective, scientific modes of research, it recognises that no observation can be separated from the realities of the researcher (Fox, 2008). Post-positivists assume that reality exists but imperfectly and that knowledge is constructed through the multiple interpretation and opinions people have (Panwar et al., 2017). Since many theories of reality influence research, the post-positivist paradigm does not commit to any specific interpretation

(Mackenzie & Knipe, 2006). Many contingencies can impact a situation and phenomena. To explore contingencies and possibilities, a thorough explanation of findings can be qualitative in nature (Bhattacherjee, 2012).

The post-positive paradigm draws upon multiple methodologies: qualitative, quantitative and mixed methods. The methodology is chosen on the basis of best-fit for the research questions and the specific research framework (Sulkunen, 2008). In this study, a qualitative post-positivist methodology was chosen for investigating secondary school CC curricula and implementation. Qualitative approaches enable key actants in the implemented and attained CC curriculum, namely the teachers and the students, to contribute their perceptions to the study. This approach to data collection and analysis allows the researcher to continue to construct knowledge of this reality without committing to any given interpretation of reality (Mackenzie & Knipe, 2006). By applying this perspective, the strength of the research is derived from the reliability and trustworthiness of the data interpretation. It thus enables this study to be situated primarily within an ontological framework as the focus of the study is to examine CC education, evidenced through curriculum documentation and implementation. This approach is further strengthened by applying a case study design, which allows an in-depth contextual examination of the research questions. The following sections discuss and justify these two design approaches.

3.1.1. Research Design

The research consists of two parts, each employing a different research design. The first part consisting of curriculum analysis employed content analysis, whereas the second part consisting of data collection from teachers and students employed a case study research design. These are described in what follows.

Content Analysis

This study applies content analysis for examining the Victorian upper secondary school curriculum. The aim of the analysis is to examine the presence of CC education within the curriculum documents. Content analysis is a research approach consisting of a set of procedures for formulating coherent inferences from the analysed documents (Bowen, 2009). Obtaining and analysing documents is considered an effective way of collecting data. Collected documents consist of manageable, practical and stable data sources that can be read and reviewed multiple times and remain unchanged through the research process (Bowen, 2009). According to O'Leary (2014), there are three primary types of documents: (i) Public records which include academic journals, books, conference papers, government publications, newspaper articles, reports, theses, statistics, and

websites; (ii) personal documents such as calendars, e-mails, scrapbooks, blogs, Facebook posts, duty logs, incident reports, reflections/journals, and newspapers; and, (iii) physical evidence such as flyers, posters, agendas, handbooks, and training materials. Documents may provide background information and broad data coverage and are thus useful for contextualising one's research within its subject or field (Bowen, 2009). In this study, the first category of documents was chosen for analysis. The Victorian curriculum forms an official government document, which mandates all educational deliveries at Victorian schools (Victorian Curriculum and Assessment Authority [VCAA], 2021). In Years 11-12, these curriculum documents are organised by subjects and referred to as 'Study Designs' (VCAA, 2021). Further details regarding the specific methods applied in the curriculum analysis are discussed below under Part A.

Case Study

This study also applies a case-study research design in order to investigate the research questions in relation to CC education implementation at a school. Case studies attempt to answer 'how' and 'why' questions (Yin, 2009); and, allow an in-depth examination of the chosen phenomenon (Creswell, 2007). Case studies enable investigations of complex phenomena within a specific context (Corcoran et al., 2004). Their main strength lies in extracting a wide range of data through interviews, documents and other sources (Zainal, 2007). This design allows the researcher to reveal numerous factors that interact to form the unique character of the subject of study (Yin, 2009). Case studies help to provide a holistic and thorough explanation of the social and behavioural issues relevant to the investigated cases (Zainal, 2007).

In a case study, researchers can either adopt a single case or multiple-case design depending on the issue in question. My study utilises a single-case design. Single cases are applied when a phenomenon is reliant on a specific social context in location and time (Harland, 2014). Single case studies can be holistic or embedded and may focus on either single or multiple units of analysis (Zucker, 2009). A single case study is chosen for this study for the reason that this study is qualitative in nature, aiming to elicit in-depth information, rather than broad generalisations. Stake (2000) identifies three types of case studies: intrinsic, instrumental and collective. Intrinsic case study research is interested in a specific case in and of itself, without the goal of generalisation or theory building (Stake, 2000). An instrumental case study is useful for research intended to discuss a case with an aim to examine a specific issue (Stake, 2000). A collective case study involves gathering data from several cases to comprehend a specific phenomenon (Stake, 2000). This research applies an instrumental case study, as it is aimed at exploring an example of CC education

curriculum implementation to gain a general understanding of CC education in Victorian senior years of schooling.

Research has shown that case studies enable researchers to study the data within a certain framework cautiously. When using a case study methodology, generally, the geographic area for a selected study is either small, or the number of participants or sites are limited (Zainal, 2007). Using a case study approach means "educational processes, problems, and programs can be examined to bring about understanding that in turn, can affect and perhaps even improve practice" (Merriam 1998, p.41).

This study aims to provide a rich and holistic account of CC education which may help in enhancing our understanding regarding the enactment of CC education at the school level, and the way in which curriculum documents enable or disable such processes. Thus the two-part design of the research study, of an initial content analysis of official curriculum documents, followed by a case study exploration of the implementation of the curriculum, may be integrated to elicit a rich, detailed understanding of CC education in the senior years of schooling in Victoria.

3.2 Methods

The research is composed of two distinct parts. The aim of the first part is to conduct a content analysis of the Year 11-12 Victorian Curriculum, in relation to CC education. The aim of the second part is to examine CC education conceptualisation and implementation in one secondary school. The first part of the research did not involve human participants, whereas the second part is a case study that involves data collection from teachers and their students. In what follows, the methods used in the two parts of the study are described separately. Part A discusses the data collection and analysis of the curriculum documents, and Part B discusses these aspects in regard to the case study. The presentation of the methods of the two parts of the study is followed by discussing the reliability and trustworthiness, and finally, the relevant ethical considerations involved in the study.

3.2.1 Part A: Curriculum Analysis

Data sources for Part A consist of the Victorian upper secondary school curriculum, the Victorian Certificate of Education (VCE) Study Designs, published by the Victorian Curriculum and Assessment Authority (VCAA). The VCAA is an independent statutory body in the Victorian state, which is responsible for developing and implementing curriculum, assessments and reporting for all Victorian students in both government and non-government schools. Upon satisfactory completion of secondary education, students receive the Victorian Certificate of Education, which enables

students to pursue further studies or training at a university or Technical and Further Education (TAFE) college or to enter into employment (VCAA, 2021). Most of the VCE study designs are accredited for a period of five years. Upon completion of the accredited period, a revised or an updated version of the curriculum is posted on the relevant VCE study page and implemented as per the specified accredited period (VCAA, 2021).

Content analysis is applied for examining the presence of CC education within the VCE study designs. Here I refer to Van Den Akker's (2004) typology to identify this curriculum as the *intended curriculum*. In doing so, I distinguish these curriculum documents from the two other curricular types, the *implemented curriculum* and the *attained curriculum*. According to Van Den Akker (2004), the *intended curriculum* refers to the official prescriptive curriculum developed and approved by curriculum developers and policymakers. The *implemented curriculum* refers to the curriculum interpretation by its users, primarily the teachers; and, the *attained curriculum* refers to the resultant learning outcomes of the students. Understanding these forms is particularly important in trying to understand the contentious issues in the curriculum.

The aim of analysing the VCE study designs is to obtain information regarding the following questions: (i) How is CC conceptualised within the subjects in which it is taught? (ii) What content knowledge is taught? And (iii) What implementation strategies for integrating CC education in the VCE curriculum can be identified? To answer these questions, there is a need to first identify in what VCE studies (subjects) CC is taught in years 11 and 12.

The method for identifying the study designs in which CC is addressed, consists of the following two-step approach: (i) Development of a set of criteria for identifying CC education within Victorian VCE study designs; and, (ii) application of these criteria for identifying study designs in which CC is taught.

Due to the complexity and multisystem nature of CC, prior to even identifying study designs in which CC is taught for the first stage of curriculum content analysis, a method tool – a set of criteria - needed to be developed for identifying the relevant CC-including VCE study designs for examination. Development of this CC-including criteria involved the extensive reading of theoretical literature regarding CC and identifying keywords that encompass the scope of the topic. The chosen keywords needed to be central terms that would appear in every discussion of CC. In other words, the chosen key terms would be such that there is no way to discuss CC without having at least one of them mentioned, thus providing a means of diagnosing which VCE study designs incorporated CC education. For deriving these key terms, the highly credible and internationally acclaimed reports by the International Panel on Climate Change (IPCC) were identified as the most

appropriate source documents for developing the key CC terms. The chosen reports are the four volumes of the IPCC Fifth Assessment Report: Impacts, Adaptation and Vulnerability (IPCC, 2014a); Mitigation of Climate Change (IPCC, 2014b); the Physical Science Basis (IPCC, 2013); and, the Synthesis Report (IPCC, 2014c). The aim of the examination of these authoritative CC source documents was to identify terms that are associated with CC, to the extent that they are inseparable from the topic.

The examination of each volume elicited a long list of terms. Through a process of systematic elimination, keywords that appeared across all four volumes remained while all the others were eliminated, resulting in four key indicator terms: 'climate change', 'global warming', 'greenhouse gases', and 'carbon dioxide'. Due to the centrality of these key terms in every CC document, there is no way to discuss CC without having at least one of the four terms mentioned. The term 'carbon dioxide' is a key term in every CC discussion however, it is also problematic in that it can also be used in other contexts, such as in teaching photosynthesis. Therefore, the presence of this term on its own is insufficient for identifying CC topics, and it was determined that this term must appear in conjunction with one of the other three key terms in order to assure that the curriculum topic addressed is *climate change*.

The IPCC defines the above terms as follows:

i. Climate change – A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2012, p. 557).

ii. Global Warming – Global warming refers to the gradual increase, observed or projected, in global surface temperature, as one of the consequences of radiative forcing caused by anthropogenic emissions (IPCC, 2014d, p. 124).

iii. Greenhouse Gases (GHG) – Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, which absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, by the atmosphere itself, and by clouds. Water vapour carbon dioxide, nitrous oxide, methane, and ozone are the primary greenhouse gases in the Earth's atmosphere (IPCC, 2012, p. 560).

iv. Carbon Dioxide – A naturally occurring gas fixed by photosynthesis into organic matter. A by-product of fossil fuel combustion and biomass burning, it is also emitted from land-use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance (IPCC, 2012, p. 556).

To identify the data sources for Part A, the curriculum analysis, all the VCE study designs (subjects) need to be searched against the above four CC indicator terms. Any study design in which one or more of the key terms appeared is identified as a subject in which CC is taught and is included in this research study for further analysis.

Once the CC-including study designs are identified for further scrutiny, a thematic analysis (Braun & Clarke, 2006) is applied for examining the presence of CC in these curriculum materials. Careful attention is given to the context in which the key CC indicator terms are used and the topics in which they are incorporated. It will be recalled, that from the literature review three focus areas were identified for guiding this research inquiry. Specifically, these are used for the Part A content analysis focus as: (i) conceptualisation of CC through key **characteristics of CC**; (ii) conceptualisation of CC through **CC topic themes**; and (iii) the implementation strategies for **curricular integration**. These themes are further described in the Findings section.

3.2.2 Part B: Case Study; CC Conceptualisation and Implementation from the Perspectives of Teachers and Students

The case study data is collected from one secondary school in Victoria. Most schools in Victoria teach in accordance with the Victorian curriculum, with a few minor exceptions. The aim of collecting data from teachers who teach CC and their students who learnt about CC, is to obtain information regarding the implemented CC education within the case of a secondary school. In what follows, I describe the participants, data collection and analysis.

The participants

For this study, all the participants are recruited from one Victorian religious non-government, co-educational school, located in the Melbourne metropolitan region. The school offers education from Foundation to Year 12 and has approximately 1800 students. One in four students in Victoria attends this parallel sector of school education in Victoria, which is allied to the government school sector in that it follows the same curriculum but with the addition of a religious focus. As with other schools in this sector, the case study school follows the guidelines as per the Victorian Curriculum: contents, achievement standards, student assessment and student reporting methods. The senior

students, Years 11 and 12, are given the opportunity to undertake either, Victorian Certificate of Education, (VCE) or the more practically focussed and less popular Vocational Education and Training (VET) and Victorian Certificate of Applied Learning (VCAL) courses. Students are offered a wide range of elective subjects to choose from based on their course. For the purpose of this study, only teachers and students who participate in the VCE course are selected for interviews. VCAL and VET teachers are not selected due to the more practical, vocational nature of the subjects in these courses.

A purposeful selection is applied to select the school and the participants within the school. Purposeful sampling is frequently used in qualitative research to identify and select information-rich cases in relation to the subject of interest as it provides detailed insights (Moser & Korstjens, 2018; Palinkas et al., 2015). In a purposeful sampling, researchers have some knowledge of the participants who are knowledgeable about or experienced with the subject of interest and are willing to participate (Bernard 2002; Creswell & Clark, 2011). I am familiar with the school from some relief teaching there and know they would therefore look favourably on my invitation to participate in this research. I also know that there is some CC education being implemented in Years 11-12 at this particular secondary school.

The sample of participants includes five teachers and seven students. The recruitment of participants follows a purposive homogenous sampling procedure. Homogenous sampling involves the selection of similar cases to investigate a particular phenomenon or a specific group of interest (Guest et al., 2013; Omona, 2013). In this case study, the group of teachers are homogenous, due to all of them being teachers who teach CC in the various VCE subjects. The group of students are also homogenous due to all of the students are studying CC in Year 11 or 12 at the case study school.

In the process of recruitment, I approached the principal of the school in-person to discuss the research project. In the meeting, I handed out the explanatory statement and requested permission to conduct the research at the school. I also asked for assistance in identifying the appropriate teachers and students for the study (note: for more detail on the information and consent forms, and prior approval sought for the research from authorities, refer to the following section in this chapter on ’Ethics‘). Once the principal’s permission was granted, the request for suitable teachers to recruit was handed to one of the school leadership members to assist in identifying and organising a meeting with the appropriate teachers. During the meeting with the teachers, I explained the research project and at the same time, handed out the Information to Participants form. All together seven teachers are involved in teaching CC-related subjects, however, only five teachers

volunteered to take part in the research. Participants who agreed to participate signed a Consent Form prior to arranging an interview time.

Convenience sampling is applied to recruiting students (Farrokhi & Mahmoudi-Hamidabad, 2012; Omona, 2013). Following the recruitment of the teachers, I asked the teachers to assist in identifying students who are studying CC topics in their Years 11-12 classes and are academically average or above-average performers in their classes. The reason for focussing on this particular group of students is derived from the study's objectives. In this study, I aim to obtain as much information as possible about the students' acquired content knowledge. Therefore, it is most appropriate to interview students who could potentially report about the relevant acquired knowledge. A convenience sampling technique is used for the selection of participants on the basis of accessibility and convenience for the researcher (Waterfield, 2018). The teachers initially listed 12 students who were invited to participate. I met with the students, explained the project, and handed them the relevant forms. A week later, I visit the school to collect the signed forms. Out of the 12 students, only seven Year 12 students and their guardians gave their consent to take part in the research. Altogether, these seven students (four boys and three girls) are studying 14 different VCE subjects, and therefore their responses to the interview questions may potentially be reflective of their studies in these 14 subjects.

In a qualitative study such as this, sample sizes tend to be small due to the emphasis on intensive contact with participants and in-depth data collection. Accordingly, the results of the study are not anticipated to be generalisable (Bradshaw et al., 2017). Therefore, the sample size does not need to be appropriately representational of the population. Qualitative research literature suggested that the sample size of five to twelve individuals per group is sufficient for many types of qualitative studies (Bradshaw et al., 2017; Guest et al., 2006; Moser & Korstjens, 2018). It is assumed that often this number of participants is indicated as sufficient for achieving data saturation (Moser & Korstjens, 2018). Data saturation is reached when no new information emerges from further interviewing, and thus the researcher may cease collecting further data (Moser & Korstjens, 2018; Rebar et al., 2011). However, some scholars contested this assertion and argue that there is no fixed rule for establishing the most appropriate sample size in qualitative research (Bradshaw et al., 2017; Fawcett & Garity, 2009). A reasonable sample size would be one that responds sufficiently to the research questions, and the aim should be to obtain rich information (Bradshaw et al., 2017).

It is also important to note that the small sample sizes in this study are directly related to the population sizes of the case study. In this particular school, only seven teachers teach CC-related subjects, and thus qualified for participation, and similarly, only 12 students are identified as

average and above in CC education, and thus qualify for participation. From within these two small case study populations, samples of five and seven are recruited respectively which represents a majority proportion of both the possible teacher and students' participants from the case study school. Table 1 presents a summary of the participant teachers and the subjects they teach, and Table 2 presents a summary of the participant students and the subjects they are learning at the case study school, at the time of the interviews.

Table 1. Subjects taught by participant teachers

Teacher specialisation*	**Subjects taught at school**
Outdoor and Environmental	Outdoor and Environmental Studies
Chemistry	Chemistry and Mathematics
Physics	Physics and Mathematics
Foods	Food Technology
Geography	Geography and Humanities

* Note: In Australian schools, it is common for teachers to teach out of their field of specialisation

Table 2. Subjects studied by participant students

Student Number	**Subjects studying at school**
1	English, Further Mathematics, Methods, Chemistry, and Physics
2	English, Further Mathematics, Health & Human Development, Physical Education, and Food Technology
3	English, Further Mathematics, Geography, Legal Studies, Health & Human Development and Physical Education
4	English, Further Mathematics, Business Management, Geography, Health & Human Development and Physical Education
5	English, Outdoor and Environmental Studies, Physics, Health & Human Development and Physical Education
6	English, Methods, Chemistry, and Biology
7	English, Further Mathematics, Media, Informatics, and Geography

Data Collection

Data from participants was collected through semi-structured interviews. An interview is a conversation between the interviewer and the interviewee for the purpose of gathering information in regard to a phenomenon under study (Alshenqeeti, 2014). According to Harrell and Bradley

(2009), interviews can be used to gather information from individuals in relation to their own beliefs, opinions, practices or knowledge. It can also be used to collect data on present and past behaviours or experiences of individuals. An interview provides opportunities for the investigator to obtain valuable and in-depth information (Harrell, & Bradley, 2009).

Semi-structured interviews were chosen for this study since they permit me to identify more variables and relationships or to go deeper into the reasoning of respondents than a tightly structured interview. In a semi-structured interview, the questions are usually standardised however the researcher has some discretion about the organisation of the questions and the order in which the questions will be asked (Scott & Usher, 2011). A semi-structured interview is often guided with questions that are rooted in the research questions or topics, and more open-ended questions are asked which create room for further discussion and clarity (Harrell, & Bradley, 2009). When working with small samples, semi-structured interviews are well suited and are regarded as useful when studying specific issues or supplementing and validating information (Laforest, 2009).

In this study, semi-structured interviews were used for obtaining teachers' perceptions regarding: (i) attitude towards CC and the role of CC education; (ii) CC topics that are being taught; (iii) their confidence in teaching CC; (iv) integration in and between disciplines; (v) understanding of CC concepts; and, (vi) the implemented pedagogy. Appendix 1a presents the interview protocol with teachers.

The semi-structured interviews with students were designed for examining students' perceptions regarding: (i) their understanding of CC concepts; (ii) their understanding of CC multisystem phenomena; (iii) attitude towards CC; and, (v) the sources of information that inform students' learning of CC. Appendix 1b presents the interview protocol with students.

Each interview was approximately 40-50 minutes in duration, in a room allocated by the principal. The times of the interviews were scheduled to fit the participants' convenience. All the interviews were audio-recorded and later transcribed.

Data analysis

The interview data was fully transcribed through carefully listening and re-listening to the recorded audios. The transcripts of the interview recordings were analysed thematically by systematically examining the data for themes or patterns. Creswell (2013) poses a systematic thematic analysis as the most valuable method for narrative analysis; "the researcher analyses what is spoken or written during data collection" (p.192). Froggatt (2001) states that the creation of links between different parts of the data that have something in common and the development of broader concepts that

encompass the themes are two analytical procedures that underpin the process of coding. Guest et al. (2012) further suggest that "coding for content begins by reviewing the analytic objective, reading the text to be analysed, and indicating the kinds of meaning that the text may potentially exemplify" (p. 68). The coding process involves combing texts or images into categories, identifying codes used in the study from various sources and then assigning a classification to the code (Creswell, 2013). Froggatt (2001) states that the researcher needs to become familiar with the data before identifying data segments for categorising or coding. Transcripts were read several times when analysing data to enhance understanding and to reveal a deeper meaning. In accordance with Froggatt (2001), links were created between different parts of the data that had something in common. These codes were further categorised into themes and concepts. This process has finally led to the organisation of the findings as answers to the research questions.

3.3 Trustworthiness

In qualitative studies, reliability and validity are derived predominantly from the notion of *trustworthiness* that is the extent to which the researcher is committed to honesty, depth and relative objectivity (Cohen et al., 2011). *Trustworthiness* is measured by meeting four criteria: *confirmability*, *credibility*, *dependability*, and *transferability* (Elo et al., 2014). *Confirmability* pertains to the authenticity of results from the study; researchers need to show that their findings are coherent and reasonably assembled (Elo et al., 2014). *Credibility* refers to the level of honesty of the results collected in the study. It indicates the degree to which the responses of participants are accurately represented by the researcher (Sinkovics et al., 2008). *Dependability* refers to the extent to which the study results can remain stable and reliable over time (Sinkovics et al., 2008). *Transferability* considers the application of results obtained in the study to similar settings and populations (Elo et al., 2014).

In this study, *confirmability* is addressed by focusing on the authenticity of the results. The five participating teachers in this study form an authentic representation of the total population of seven teachers who teach CC in VCE classes at this particular school. Similarly, the seven participating Year 12 students in this study, represent their CC education acquired across 14 subjects that these students cumulatively study at the school. Further *confirmability* is achieved by using the same interview protocol for interviewing all the teachers, and similarly, the same interview protocol for interviewing all the students. The consistency in the interview questions supports the coherency of the obtained data.

The *credibility* of the research is ensured by truthful and honest reporting. This is achieved by using direct quotes as evidence in the Results chapter. By providing direct quotes and extracts from the curriculum documents and transcripts, the reader can evaluate the extent to which the interpretation of this data is accurate. According to Elo et al. (2014), the use of quotations strengthens both the relationship between the results and the data as well as the richness of the data. Further *credibility* is achieved through the designing of the semi-structured interview questions. The focus of the questions is drawn from the objectives of the study and also related questions that emerged from the VCE study design analysis in the first stage of the research. Thus, the interview questions are informed by authoritative (IPCC and VCE curricula) sources. The questions were also peer-reviewed when critiqued and refined with the assistance of my supervisors, ensuring the credibility of the study. In addition, during the interview with the students, I found after the fourth interview, the data started to be replicated or reached saturation. However, I continued to collect data from all of the participants, to ensure the credibility of observed data saturation.

Dependability is achieved by using three different data sources: the VCE curriculum, teachers, and students. A careful analysis of the data, from each source, is done and matched against each other before conclusions are made. In this way, the use of multiple data sources means that the findings are reliable and dependable, due to being obtained from multiple sources and perspectives.

The *transferability* criterion is related to the aspect of generalisability. The population in Part A of the study is the entire suite of VCE study designs, and this population is analysed in full. Thus, the results are generalisable to this population. In regard to Part B of the study, the methods used for collecting data from teachers and students are transferable to other similar settings. The interview protocols are not specific to the particular school at a particular location. However, the data collected is particular to this school and therefore has limited generalisability and transferability.

Overall, the rigour applied to all phases of the study: planning and instruments development, data collection, and analysis, ensure the trustworthiness of this study's findings.

3.4 Ethics

Ethical considerations are of prime importance when conducting research with human subjects and particularly with minors, such as the students in this study. Ethical conduct needs to apply to every stage of the research, beginning with conceptualisation, designing, data collection, analysis, interpretation and writing of results (Meltzoff, 2005). Levels of risk usually depend on the research area and the participants. The British Education Research Association refers to ethics in research involving humans, as follows:

> Individuals should be treated fairly, sensitively, with dignity, and within an ethic of respect and freedom from prejudice regardless of age, gender, sexuality, race, ethnicity, class, nationality, cultural identity, partnership status, faith, disability, political belief or any other significant difference (British Education Research Association [BERA], 2011, p 5).

The human participants in this study are teachers and their students. The teachers are regarded as adults who are not associated with any particular vulnerability. However, this study is considered a 'high risk' study due to the fact that it involves participants under 18 years of age. Accordingly, ethical research methods are diligently attended to in the study design.

Prior to commencing this study, ethics approvals were submitted and obtained from the three institutions governing research in this study. These are: Victoria University Human Research Ethics Committee, Approval ID HRE17-186; Victorian Education Department, Approval ID 2017_003539; and, the religious non-government Victorian school, Approval ID 1004. The specific details of the religious sector remain confidential in order to ensure the school's anonymity. In addition to the three governing bodies' approval, written approval was also obtained from the school's principal prior to proceeding with the study.

Once approvals were obtained from the relevant institutions, further approvals were sought from the participants and their guardians. All the participant teachers received Information to Participants forms (see Appendix 2a) and were given time to consider their participation. The teachers were asked to sign a Consent Form prior to participation (see Appendix 2b).

Student participants were handed out the following forms: (i) Information to Participants for parents/ guardians (see Appendix 3a); (ii) Information to Participants for students (see Appendix 3b); (iii) Consent Form for parents/guardians (see Appendix 4); and (iv) Assent Form for students (see Appendix 5). Obtaining the students' assent to participate was seen as an important recognition of the young people's maturity and agency as almost-adults, despite legal consent power residing with their parents/guardians. This follows contemporary guidelines for researching with young people that recognises their rights (Spriggs, 2010; UN, 1989). The interviews did not proceed without the signing of all the Consent and Assent forms.

All the participants were informed that the research information would be kept confidential and would only be used for the purpose of the study. Confidentiality relates to safeguarding the data disclosed to the researcher by the participants, which is a key component of the relationship of trust and respect between the researcher and the participant (Petrova et al., 2018; Sauders et al., 2015).

De-identifying the school and the participants allows researchers to enhance the protection of the identity of the participants and to maintain the value and integrity of data (Sauders et al., 2015). In presenting the thesis, no reference was made to the details of the school. Each participant was assigned a code name to differentiate them from each other. Students were assigned as Student 1, 2, 3 and so on. Teachers were identified by the subjects they were teaching. For example, Geography Teacher, Chemistry Teacher and so on. With these code names, and no school identifying details, the participants' privacy is protected for general publication. However, the research participants may be able to identify each other's code names with their 'insider' knowledge in the final written thesis or subsequent publications. With this in mind the findings have been reported as far as possible in a non-judgemental manner; not portraying any participant in a deficit way but rather acknowledging the participants' contributions to the community of teachers and learners of CC. This is also in recognition that teachers often teach subjects that are out of their field of specialisation. Thus, the code names of teachers according to the subject they teach is not an indication of their own specialist field knowledge. But the reason for identifying teachers by their subject is because this type of coding allows the readers to make clear connections between the subject curriculum and the teaching of the subject. This aspect of comparing the three levels of the formal curriculum, implemented curriculum and attained curriculum is inherent to this study and permeates all stages of the analysis, making the subject identification essential at the curriculum level and the teacher level.

In addition to de-identifying the participants, during the interview sessions, the participants were assured that they were free to opt-out any time, with no questions asked, and that they may ask to withdraw their transcripts. The participants were also notified that in the event their participation in the interview affects them in any way, they were free to contact the researcher who would refer them to appropriate support.

The site for the data collection is a Victorian secondary school. The interviews were conducted in class and meeting rooms as per the school principal's discretion. Schools have their own Occupational Health and Safety (OH&S) policy in-place. To ensure the participants' safety during the interviews, the school OH&S information was obtained from the school prior to proceeding with the interviews and followed accordingly. The researcher is also a registered teacher in Victoria and as such has been certified for working with students in schools, which is a requirement for any school visitors. Thus, it is believed that in this study the research has taken all the precautionary steps to ensure the safe and ethical conduct of the study. The following chapter presents the findings obtained from applying the described methods in this study.

Chapter Four
Findings

4. Introduction

The findings presented in this chapter are organised in accordance with the two component parts that constitute this research study. These are: Part A, the VCE study designs (curriculum) analysis, and Part B, the analysis of a case study consisting of CC implementation at one Victorian secondary school. The analysis of the VCE study designs provides insights into the conceptualisation of CC education within the formal curriculum. The case study findings provide in-depth understandings regarding the ways in which CC education is enacted in a school. Following the analysis of the above two parts, these are brought together in a comparative analysis, presented in the final part of this chapter. The aim of this analysis is to identify potential gaps, as well as alignments between the formal curriculum and the enacted curriculum (Van den Akker, 2004), as it is perceived and applied in a non-governmental secondary school.

4.1 Part A: VCE curriculum analysis

The first part of the research involves published document analysis. It attempts to answer the first research question: How is CC represented in the study design for years 11-12 in the VCE curriculum and how is it conceptualised? An analysis tool - a set of key indicator terms criteria - was developed and applied for identifying study designs in which CC is presented (please refer to the Methodology chapter for a detailed description of the process).

The VCE Curriculum consists of 96 study designs (VCAA, 2021). Out of the 96 VCE study designs, there are 46 non-language subjects which are grouped into ten disciplines and one investigative study. The remaining 50 study designs are for various languages which are primarily aimed at language competency, not content-focused. The developed key words criteria were applied to examining all 96 VCE study designs. The study designs in which any of the indicator terms ‘climate change’, ‘global warming’, or ‘greenhouse gases’ appeared, as well as the appearance of ‘carbon dioxide’ in conjunction with any of the other key terms, were identified as CC-including curriculum documents for further analysis. Out of 96 study designs, the CC indicator term analysis reveals that CC is present in only ten subjects. These are: Agricultural and Horticultural Studies; Australian Global Politics; Chemistry; Economics; Environmental Science; Food Studies; Geography; Outdoor and Environmental Studies; Physics; and Systems Engineering. In each of these ten subjects, a student might have the opportunity to learn about some aspects of CC at the VCE level.

The analysis of CC conceptualisation within each of these CC-containing study designs consists of the examination of three main aspects of how CC is positioned in the curriculum documents that have been derived from the literature. The three foci for analysis of the VCE study designs are: (i) conceptualisation of CC through key characteristics of CC; (ii) conceptualisation of CC through topic themes; and (iii) the implementation strategies for curricular integration. These three aspects are explained in the following.

Conceptualising CC through key CC Characteristics

When examining the conceptualisation of CC in the curriculum, it is important to understand how CC is characterised by the curriculum, as a body of knowledge beyond just a list of topic inclusions, to identify core underpinning understandings or propositions. In other words: What characteristics typically permeate and connect discussions related to CC? The literature review revealed three characteristics of CC. These are: (a) CC is complex and cross (multi- inter- trans -) disciplinary (Ingwesen et al., 2013; Krellenberg & Barth, 2014; Tolppanen & Aksela, 2018); (b) CC involves a degree of uncertainty concerning the impacts and their extent; and (c) it inherently involves human action (Hamin & Marcucci, 2013). These characteristics were applied in the process of analysis for examining the extent of their expression within the study designs.

Conceptualising CC through CC Topic Themes

CC is a complex body of knowledge drawing upon multiple disciplines, including: science (Jacobson et al., 2017); environmental studies (Diaz, 2015); socio-cultural studies (Eisenack 2012; Winkler 2016); ethics (Stubbs et al., 2018); psychology (Maier et al., 2018); policies and politics (Petroni, 2009; Hamin & Marcucci, 2013); economy (Ali, 2018), and more. Examination of the IPCC reports reveals that CC topics are often organised around themes of: Observed changes and their causes; CC projections; risks and impacts; and, adaptation and mitigation. Each of these broad themes is subdivided into sub-themes, together covering the vast scope of scientific, economic, social, environmental and political aspects of CC causes, impacts and responses (IPCC: Synthesis Report, 2014c, p. vii). Due to the wide range of CC topics and their multi-system nature, it is difficult to confine them into traditional subject areas. However, for the purpose of analysing the curriculum, the various topics represented within the study designs were roughly classified as belonging to either one of the following CC topic themes: science, environment, society & culture, policy, and economy that are aligned with the IPCC themes from IPCC's Synthesis Report (IPCC, 2014c).

CC Curricular Integration

The literature review revealed two main approaches to CC integration. Either teaching CC as a topic on its own (Gilmore, 2017) or dispersing it across the curriculum and teaching various aspects of CC within a group of curricular subjects (Middleton, 2011). This study's examination of the VCE curriculum is aimed at identifying the approach taken and examining how the approach is executed across the study designs.

Together, the three aspects of CC characteristics, topics and integration, are understood to comprise CC conceptualisation by the study designs. In what follows, I present an in-depth analysis of each of the 10 study designs, based on this framework of conceptualisation. At the end of the in-depth analysis of each study design, a summary is presented. The analysis of the ten study designs is organised by the alphabetic order of the subjects' titles.

Agriculture and Horticultural Studies

CC Characteristics

The Agricultural and Horticultural Studies study design identifies CC as complex and inherently involves human actions, however, it does not present the characteristics of CC models' uncertainty. In its approach to CC, this study design introduces students to the two ways systems impact, that is, the effect of agricultural and horticultural processes on CC and the likely impact of CC on agricultural and horticultural production. For example, the study design emphasises the "effects of agricultural and horticultural processes and operations on CC" (VCAA, 2015, p. 28) as well as "climate change and its likely impacts on agricultural and/or horticultural production" (VCAA, 2015, p. 28).

In regard to CC uncertainty, while the study design does not directly address this, it does implicitly suggest some uncertainty in future scenarios, for example: "Scenario planning that uses 'What if …' statements are a useful approach in helping students to analyse and evaluate viable options for rectifying degraded land and water, or to consider adaptations in response to the effects of CC" (VCAA, 2015, p 34).

CC Topic Themes

In this study design, CC is integrated into Unit 3: Technology, Innovation and Business Practices; Current Management Techniques and Unit 4: Sustainable Management; Sustainability in Agriculture and Horticulture (VCAA, 2015). The CC topic themes in this study design include the science, environment, society & culture, and economy, while the policy is not addressed. The Agriculture and Horticultural Studies uses a futures orientation approach in addressing the CC theme of adaptation and mitigation.

The Agricultural and Horticultural Studies study design unambiguously incorporates scientific and environmental topics such as modification techniques to alter or control local climatic and environmental conditions, CC impacts and greenhouse gas emissions (VCAA, 2015). Special attention is given to adaptation strategies. Specifically, the study design addresses resources management and modified practices that would enable the agribusinesses to adapt to CC and sustain food production. In this regard, it is stated in the Agricultural and Horticultural Studies study design that "Unit 4 focuses on the sustainable management of agricultural and horticultural businesses and how businesses will increasingly need to adapt in order to maintain sustainable food and fibre production" (VCAA, 2015, p. 34). Students in this unit "undertake a media analysis that examines the potential effects of CC and how agribusinesses are adapting to these effects" (VCAA, 2015, p. 57). In doing so, the science, economic, social and environmental aspects of CC are addressed however, policy aspects of CC are missing.

CC curricular integration

The Agricultural and Horticultural Studies study design does not address the issue of integrating CC beyond this specific VCE subject.

In summary, two out of three CC characteristics are apparent in the study design: complexity and connected to human actions. The CC topic themes addressed consist of: science, economy, society & culture, and environment. The study design does not address CC integration.

Australian and Global Politics

CC Characteristics

The Australian and Global Politics study design identifies CC as involving human actions however, it does not present the CC characteristics of complex and cross-disciplinary, and CC models' uncertainty. In its approach to CC, the study design directs students to critically analyse the effectiveness of responses to CC and outline ways to address the challenges posed by the crisis. In this regard, it was stated that the study "explores the nature and effectiveness of global responses to crises such as CC, armed conflict, terrorism and economic instability" (VCAA, 2018, p 6). In addition, the curriculum emphasises the challenges posed by CC and the need to make decisions in relation to tackling these challenges. For instance, "students consider whether national interests prevail over global climate challenges, and how other economic priorities and political factors play a role" (VCAA, 2018, p. 36).

CC Topic Themes

In the Australian and Global Politics study design, CC is integrated within Unit 4: Australian Public Policy; Foreign Policy, and Global Challenges; Global Crises (VCAA, 2018). The CC topic themes

covered in this study design are environment, society & culture, policy and economy, while science is not addressed. The focus of the study is on considering the formulation and implementation of policies such as crisis diplomacy, international cooperation, globalisation and unilateralism.

In the Australian Public Policy topic in Unit 4, CC and the environment, are considered as one of the key challenges facing contemporary Australian foreign policy. In this regard, the study design states students should study:

> Two of the following key challenges facing contemporary Australian foreign policy: global and regional conflicts; humanitarian crises and natural disasters; the threat of global terrorism; CC and environmental issues; the economic development of the region; and, refugees, people smuggling and trafficking in persons (VCAA, 2018, p. 26).

Similarly, in the topic entitled Global Challenges; Global Crises, CC is considered as one of the global crises where "Two global crises are selected from the following: CC, armed conflict, terrorism, and economic instability" (VCAA, 2018, p. 36). The study design promotes further development of students' understanding of CC through learning: "the causes; the responses from relevant global actors and their effectiveness; challenges to achieving effective resolutions; key aspects of the crisis of CC" (VCAA, 2018, p. 36).

The emphasis on CC in the Australian and Global Politics study design is at the political level. According to the Area of Study 2 of the Global Crises topic in Unit 4, "CC presents policymakers with significant difficulties, some of which stem from responses requiring global cooperation by states at an unprecedented level" (VCAA, 2018, p. 36). The curriculum states: "consider whether national interests prevail over global climate challenges, and how other economic priorities and political factors play a role" (VCAA, 2018, p. 36).

The science of CC is not addressed in the Australian and Global Politics subject with the emphasis of the study design on the social & cultural, environmental, political and economic aspects of CC.

CC Curricular Integration

The Australian Global Politics study design does not address the issue of integrating CC beyond the specific VCE subject.

In summary, one out of three CC characteristics is apparent in the study design, namely involving human actions. The CC topic themes addressed consist of: environment, society & culture, policy and economy. The study design does not address CC integration.

Chemistry

CC Characteristics

The Chemistry study design does not demonstrate any characteristics of CC.

CC Topic Themes

In the Chemistry study design, aspects of CC are integrated within Unit 3: How Can Chemical Processes be Designed to Optimise Efficiency (VCAA, 2016a)? The CC topic themes covered in this study design include only the scientific aspects, while the other topics: environment, society & culture, policy, and economic are not addressed. The focus is on the technical aspect of CC, particularly on the production of greenhouse gases. The Unit focuses on calculations related to combustion of fuel, heat energy release, the net volume of greenhouse gases and the production and application of greenhouse gases. The key knowledge area, outcome 1 of Unit 3 states: "the comparison of the use of fuel cells and combustion of fuels to supply energy with reference to their energy efficiencies (qualitative), safety, fuel supply (including the storage of hydrogen), production of greenhouse gases and applications" (VCAA, 2016a, p. 26). Overall, CC is presented in this study design through a narrow focus on technical scientific and engineering aspects.

CC Curricular Integration

The Chemistry study design does not address the issue of integrating CC beyond the specific VCE subject.

In summary, none of the characteristics of CC is apparent in the study design. The CC topic themes addressed consist of science only. The study design does not address CC integration.

Economics

CC Characteristics

The Economics study design identifies CC as complex, however, it does not present the CC characteristic of uncertainty and the inherent involvement of human actions. The complexity dimension of CC in the study design is exemplified in the Key Knowledge Area, Outcome 1 of Unit 2: Contemporary Economic Issues: "Economic and environmental costs of economic growth such as CC, depletion of natural resources and deterioration of common access resources" (VCAA, 2017a, p. 14).

CC Topic Themes

In the Economics study design, CC is integrated into Unit 2: Contemporary Economic Issues (VCAA, 2017a). The CC topic themes in this study design include the environment and economy while science, society & culture, and policy are not addressed.

The study design considers CC as one of the costs of economic growth. However, the study design does not specify the implications of CC, as is demonstrated in the knowledge outcome quoted above. Overall, in this study design, CC is presented through a focus on the environmental and economic costs of economic growth.

CC Curricular Integration

The study design does not address the issue of integrating CC beyond the specific VCE subject.

In summary, one out of three CC characteristics is apparent in the study design, namely complexity. The CC topic themes addressed consist of dimensions of environment and economy. The study design does not address CC integration.

Environmental Science

CC Characteristics

The Environmental Science study design identifies CC as complex and that CC models' uncertainty. However, it does not present the characteristics of involving human action. The complexity is exemplified in key knowledge of Area of Study 2, Unit 4, as follows: "Major factors that alter Earth's atmosphere; that give useful information about changes in the climate; and, consequences of changing the composition of gases in the atmosphere" (VCAA, 2016b, p. 30). The presence of CC models' uncertainty is exemplified in the key knowledge of Area of Study 3, Unit 4, by addressing the measurement of environmental indicators and recognising the limitations of provisional and incomplete data, as this often involves uncertainty (VCAA, 2016b).

CC Topic Themes

In the Environmental Science study design, CC topic themes are integrated into Unit 2: How Can Pollution be Managed? and Unit 4: How Can the Impacts of Human Energy Use be Reduced? (VCAA, 2016b). The CC topics in this study design include: science, environment, society & culture, and economy, while the policy is not addressed.

Unit 2 highlights the production and effects of pollutants. According to the Area of Study 2 of Unit 2, there are three categories of pollution: air, water and soil. Topics related to CC are found in air pollution. For example, the study design states:

> Contamination of the atmosphere that disturbs the natural composition and chemistry of the air may be caused by particulate matter such as dust or excessive gases such as carbon dioxide that cannot be effectively removed through natural cycles, including the carbon and nitrogen cycles (VCAA, 2016b, p. 19).

The study further addresses pollution management: “the social, economic and ethical implications relevant to pollution management options of the three selected pollutants” (VCAA, 2016b, p.21).

Unit 4 focuses on scientific aspects related to CC. According to the study design: “the student should be able to explain the causes and effects of changes to Earth’s climate, compare methods of measuring and monitoring atmospheric changes, and explain the impacts of atmospheric changes on living things and the environment” (VCAA, 2016b, p. 30). Overall, the interdependency of systems is apparent in the connections made between science, environment, society & culture, and the economy.

CC Curricular Integration

The study design does not address the issue of integrating CC beyond the specific VCE subject.

In summary, two out of three CC characteristics are apparent in the study design: complexity and CC models’ uncertainty. The CC topics addressed consist of: science, environment, society & culture and economy. The study design does not address CC integration.

Food Studies

CC Characteristics

The Food Studies study design identifies CC models’ uncertainty however, it does not present the characteristics of complexity and cross-disciplinarity and involving human actions. In its approach to CC, this study design allows students to study food issues, challenges and futures in relation to the risks associated with biosecurity, CC and loss of biodiversity (VCAA, 2017b).

CC Topic Themes

In the Food Studies study design, CC is integrated into Unit 4: Food Issues, Challenges and Futures (VCAA, 2017b). The CC topic themes addressed in this study design are environment, society & culture, and economy, while science and policy are not addressed. Dimensions of environment, society & culture, and economy are integrated into the Unit through the topic of food production. For example: “The environmental sustainability of primary food production in Australia, including use of fertilisers, pesticides and water, choice of crops and animals for farming, and risks associated with biosecurity, climate change and loss of biodiversity” (VCAA, 2017b, p 19). These aspects are further connected to the environmental implications associated with food processing and manufacturing, retailing and consumption.

CC Curricular Integration

The study design does not address the issue of integrating CC beyond the specific VCE subject.

In summary, one out of three CC characteristics is apparent in the study design, namely, CC models' uncertainty. The CC topic themes addressed are within the fields of environment, society & culture, and the economy. The study design does not address CC integration.

Geography

CC Characteristics

The Geography study design identifies CC as complex and involving human action. However, it does not present the characteristic of CC models' uncertainty. CC is conceptualised as a cause of natural disasters. According to Unit 1: Hazards and Disasters, CC is considered as one of the components adding to environment-related hazards: "hazards caused by current climate change such as rising sea levels or increased intensification of weather events" (VCAA, 2016c, p. 14). As well as exploring the relationship between CC and increased intensification of weather events, the Unit further explores the consequences of CC and the social and economic costs involved in mitigation and adaptation.

The complexity of CC is also addressed in Unit 3: Changing the Land, where the impact of natural land cover transformation is addressed, by considering geomorphological events, plant succession and CC.

The involvement of human action in CC as a key characteristic is exemplified in Unit 1 as follows: "This unit investigates how people have responded to specific types of hazards, including attempts to reduce vulnerability to, and the impact of, hazard events" (VCAA, 2016c, p. 14).

CC Topic Themes

In the Geography study design, CC is integrated within Unit 1: Hazards and Disasters and in Unit 3: Changing the Land (VCAA, 2016c). The CC topics addressed in this study design are environment, society & culture and economy, while science and policy are not addressed.

Unit 1 addresses different types of hazards: geological/geophysical, hydro-meteorological, biological and technological. The study conceptualises CC as causing hazards. According to the study design, hazards include: "oil spills, air pollution, radiation leaks, flooding primarily caused by land clearances, epidemics caused by poor living conditions, and hazards caused by current CC such as rising sea levels or increased intensification of weather events" (VCAA, 2016c, p. 14).

The topic extends to include the social and economic implications of the hazards. Students, through investigation, get to learn about human responses to specific types of hazards; the impacts, events and reducing vulnerability.

Unit 3 addresses changes to the natural land cover of forests, grasslands, tundra, wetlands and land covered by ice and water. According to the study design, "natural land cover has been altered by many processes such as geomorphological events, plant succession and CC" (VCAA, 2016c, p. 20). The study further elaborates on human actions leading to land cover modification, effectively including dimensions of environment, society & culture, and economy in this study.

CC Curricular Integration

The Geography study design does not address the issue of integrating CC beyond the specific VCE subject.

In summary, two out of three CC characteristics are apparent in the study design: complexity and inherently involves human actions. The CC topics addressed consist of environment, society & culture, and economy. The study design does not address CC integration.

Outdoor and Environmental Studies

CC Characteristics

The Outdoor and Environmental studies study design identifies CC as complex. However, it does not present the characteristics of CC models' uncertainty and involvement of human action. The complexity is represented through interconnections made between CC, society and the environment, in Unit 4 (VCAA, 2015b). However, unfortunately, CC is understood as a natural change, rather than as a complex human-induced calamity. This is exemplified in the following statement: "Scientific understandings of specific outdoor environments, including effects of natural changes to environments on people and places such as day to night, seasons, tides, fire, flood, drought, migration, succession, and climate change" (VCAA, 2015b, p. 16). This statement is scientifically incorrect because it implies that natural changes are causing CC, in the same way, that they cause seasons and tides.

CC Topic Themes

In the Outdoor and Environmental Studies study design, CC is integrated within Unit 2: Discovering Outdoor Environments; Unit 3: Relationships with Outdoor Environments; and Unit 4: Sustainable Outdoor Relationships (VCAA, 2015b). The CC topic themes in this study design incorporate the fields of environment and society & culture, while policy and economy are not addressed, and, as indicated above, the science aspects are not correctly addressed.

In Unit 3 under Area of study 2: Contemporary Relationships with Outdoor Environments, the social and political/policy aspects are mentioned in the key learning outcome as follows: "The factors influencing contemporary societal relationships with outdoor environments, including social

and political discourses about CC, water management, biosecurity and other contemporary environmental issues" (VCAA, 2015b, p. 20).

The relationships between society and the environment are further addressed in Unit 4 under Area of study 1: Healthy Outdoor Environments in the key knowledge that is listed as: "the potential impact on society and outdoor environments of land degradation, introduced species, climate change, urbanisation and other significant threats" (VCAA, 2015b, p. 23). Topics such as effects of technologies, commercialisation and portrayals of the outdoor environment are the focus of this Unit. CC is considered as one of the issues of the outdoor environment alongside water management, biosecurity, land degradation, introduced species and other contemporary environmental issues. Overall, in this study design, the emphasis is on the science, environment, and society & culture.

CC Curricular Integration

The study design does not address the issue of integrating CC beyond the specific VCE subject.

In summary, one out of three CC characteristics is apparent in the study design, namely complexity. The CC topic themes addressed consist of environment and society & culture. The study design does not address CC integration.

Physics

CC Characteristics

The Physics study design does not demonstrate any characteristics of CC.

CC Topic Themes

In the Physics study design, CC related topic themes are integrated within Unit 1: What Ideas Explain the Physical World? (VCAA, 2016d). The topic addresses science aspects only, while environment, society & culture, policy, culture and economy are not addressed. The focus is on climate science only, with no mentioning of CC. For example, focus areas are listed as: "Thermodynamics and climate science; Issues related to thermodynamics" (VCAA, 2016d, p. 15). Thus, even the CC science itself is narrowed down to climatology. The Unit addresses the mechanisms of how the earth heats and how heat gets trapped in the atmosphere. It introduces students to greenhouse gases through the directive: "students examine the environmental impacts of Earth's thermal systems and human activities with reference to the effects on surface materials, the emission of greenhouse gases and the contribution to the enhanced greenhouse effect" (VCAA, 2016d, p. 14). The role of the greenhouse gases in determining Earth's thermal energy is specifically addressed as follows: "model the greenhouse effect as the flow and retention of thermal

energy from the Sun, Earth's surface and Earth's atmosphere" (VCAA, 2016d, p. 15), as well as: "analyse the evidence for the influence of human activity in creating an enhanced greenhouse effect, including affecting surface materials and the balance of gases in the atmosphere" (VCAA, 2016d, p. 15). The CC focus of this study design is on climate science, where CC is presented through a narrow focus on only the scientific aspects.

CC Curricular Integration

The study design does not address the issue of integrating CC beyond the specific VCE subject.

In summary, none of the CC characteristics is apparent in the study design. The CC topic themes addressed consist of science only. The study design does not address CC integration.

Systems Engineering

CC Characteristics

The Systems Engineering study design does not demonstrate any characteristics of CC. However, CC is conceptualised as a problem of technology.

CC Topic Themes

In the Systems Engineering study design, CC is integrated within Unit 3: Integrated Systems Engineering (VCAA, 2019). The CC topic themes addressed in this study design include science and environment, while society & culture, policy and economy are not addressed. The focus of the study design is on technical solutions to global challenges as exemplified through the directive to: "Develop an understanding of how technologies have transformed people's lives and can be used to solve challenges associated with climate change, efficient energy generation and use, security, health, education and transport" (VCAA, 2019, p. 5). CC is considered as one of the global challenges. This challenge is addressed in the Unit by considering technological systems for dealing with fossil fuel efficiency, capture and storage, renewable energy and reducing carbon emissions. For example:

> Students consider the technological systems developed to capture and store renewable energy and technological developments to improve the credentials of non-renewables, including gains in efficiency through the transformation of non-renewables to other types of energy such as electricity, reduction of CO_2 emissions with non-renewable fuel technologies and hybrid technologies (VCAA, 2019, p. 25).

Overall, CC is presented in this study design through a narrow focus on technical scientific and engineering aspects.

CC Curricular Integration

The Systems Engineering study design does not address the issue of integrating CC beyond the specific VCE subject.

In summary, none of the CC characteristics is apparent in the study design. The CC topics addressed consist of science only. The study design does not address CC integration.

4.1.1. Summary of Part A

The analysis of the VCE study designs revealed that CC is taught only in ten subjects out of the 96 subjects offered at the VCE level. Table 3 presents a summary of the analysis of the ten study designs, in relation to their conceptualisation of CC characteristics (complex, uncertain and includes a human action dimension) and the broad topic themes taught (science, environment, society & culture, policy and economy).

Table 3. Summary of CC conceptualisation through CC characteristics and topic themes, by study design.

Study Designs	**CC conceptualisation**	
	CC characteristics	*CC topic themes*
Agricultural and Horticultural Studies	Complex Human action dimension	Science Environment Society & culture Economy
Australian Global Politics	Human action dimension	Environment Society & culture Policy Economy
Chemistry Economics	Not presented Complex	Science Environment Economy
Environmental Science	Complex Models' uncertainty	Science Environment Society & culture Economy
Food Studies	Models' uncertainty	Environment Society & culture Economy
Geography	Complex Human action dimension	Environment Society & culture Economy
Outdoor and Environmental Studies	Complex	Science Environment Society & culture
Physics	Not presented	Science
Systems Engineering	Not presented	Science Environment

Examination of Table 3 reveals that in regard to CC conceptualisation, none of the study designs presents a complete conceptualisation of CC characteristics; indeed Chemistry, Physics and Systems Engineering do not address the fundamental characteristics of CC whatsoever. The findings suggest that in the process of developing the VCE study designs, attention was not given to

conceptualising CC and its role within the curriculum. This finding is highly important, since the lack of such consideration has a flow-on effect on all other aspects of the curriculum development, as demonstrated by the findings related to the topics taught and the integration of CC.

Examination of the topics taught reveals once again a partial representation of the scope of CC. Five CC topic themes were identified in this study as critical for multi-disciplinary integration in the teaching of CC. These are science, environment, society & culture, policy and economy. However, none of the study design addresses all five areas. Only four study designs address four areas out of the five, and the remaining study designs address between one and three. These findings clearly suggest that CC appears as a fragmented topic across the curriculum, addressed as pieces of information. This lack of a holistic approach to teaching CC seems fundamental to the VCE curriculum.

Similar to the findings regarding CC conceptualisation and topics, the findings related to CC integration also point to a lack. None of the study designs addresses the question of integration of CC within the suite of the VCE study designs. While different study designs address different aspects of CC, nowhere in the curriculum, the question of how students may complement their fragmented knowledge is addressed. The study designs seem to work in isolated 'silos'. There are no cross-disciplinary links between study designs. This indicates a hidden assumption that each study design is a one-stop-shop for teaching CC. Each study design seems to disregard content that may be addressed in others.

Overall, through the analysis of the VCE curriculum, it seems that CC conceptualisation and topic coverage is incomplete within the ten study designs that evidenced CC inclusion, from a full family of 96 VCE study designs. The next section of findings examines how this incomplete conceptualisation is understood and enacted within teaching and learning.

4.2 Part B: Implementation analysis

Part B of the study is a case study of one school's implementation of CC education at the senior level of schooling. Data collected at the school were analysed with the aim of addressing the question: How is climate change education conceptualised and implemented in years 11-12, from the perspectives of teachers who teach CC and their students studying under their guidance? In what follows, I first present the findings related to teachers' perspectives, followed by the students' perspectives.

4.2.1 Teachers' perspective

The study focused on the following aspects related to teachers' perspectives: (i) the need to teach CC and the representation of CC education within VCE study designs; (ii) the ways in which CC may best be taught; (iii) their confidence in teaching; (iv) their understanding of CC concepts; (v) CC topics that are being taught; (vi) the integration of CC education in and between disciplines; and finally, (vii) the strategies that teachers apply when teaching CC. The findings within each of these seven aspects are explored in the following sections.

The need to teach CC and the representation of CC education within VCE study designs

Teachers were asked to express their views in regard to the need to teach CC and the implementation of CC education within the VCE study designs.

All the teachers expressed a similar sentiment when asked about the need to teach CC. They all demonstrated a high level of concern in regard to CC and agreed that there is a need to teach CC to secondary school students. They also acknowledged that CC is one of the most pressing issues facing humanity in the present time, it is ever-increasing, and it needs urgent attention.

The Geography Teacher further expressed the view that CC is a topic that is interconnected to all the units and topics in the Geography curriculum. The teacher stated that "… it's all interconnected just as… because you can't do one without the other… so the cyclical fit" (Geography Teacher). In regard to the need to teach, this teacher viewed it as a moral imperative. The teacher explained: "I don't think you have any choice, if you gonna be a morally acceptable geography teacher not to teach it…" (Geography Teacher). In this teacher's class, CC is incorporated into all the topics of geography.

Curriculum designers have placed great effort into developing the study designs. However, when it comes to implementation, teachers have their own opinions. When asked whether curriculum developers have placed enough emphasis on CC education, the opinions varied.

The Chemistry Teacher could not identify any reference to CC within the curriculum and believed that the topic is not there in the curriculum. This view contrasts with the analysis in Part A of this study, using the developed key terms diagnostic criteria, that identified in Unit 3 the CC indicator term 'greenhouse gases' was included in the unit focus on energy efficiencies. The teacher qualified that CC is a constantly evolving field, and as such, it is a challenge to have a rigid curriculum around it.

The Physics Teacher seemed satisfied with the Physics study design. The teacher expressed the view that the study design enables students to develop critical thinking skills where these, in turn, assist students in making informed decisions. the Teacher stated that:

> Once you discuss the physics, what's happening, so children can then draw their own conclusions as to why the climate is changing… it makes sure they understand the mechanism behind… fairly balanced point of view to present that information rather than rely on the hysterical data (Physics Teacher).

It appears as though the Physics Teacher perceives the science as counteracting what the teacher referred to as 'hysterical data'. This is somewhat surprising in light of the fact that the scientific data is alarming, and climate scientists think that this data should be a cause for urgent action.

The Food Studies Teacher was discontented with the study design. The teacher expressed the view that CC education is understated within the food technology study design despite the fact that it had great potential to be integrated within the curriculum. The teacher further stated that more components of CC education need to be incorporated within the Food Technology study design.

The Geography Teacher expressed mixed views. The teacher acknowledged that the study design does incorporate the reasons and the impacts of CC but not to the required extent. The teacher stated that: "I don't think its prescribed enough for my liking… it [CC] underpins everything when we look at environmental change and management" (Geography Teacher). The Geography Teacher's responses suggest that when implementing the curriculum, the teacher goes beyond the intended curriculum, and implements CC education holistically throughout the teaching of the Geography units.

The participants also expressed their view in regard to the Year levels appropriate for teaching CC. Two of the teachers expressed the opinion that CC education needs to be implemented at a very young age, particularly at the foundation (school entry) level. A third teacher was less focussed on the question of the Year level, and instead emphasised the need for a dedicated CC curriculum.

The findings regarding the teachers' views of the need to teach CC indicate that teachers were unanimous with regard to the need to teach CC. They all thought that this is important. However, when asked for their opinion about the presence of CC within their subjects' curricula, their opinions varied. Some expressed a strong critique of the lack of CC presence, and others thought that the curriculum was well balanced.

Perception of the ways in which CC may best be taught.

In response to the question of how CC may be taught, four out of five teachers provided explicit descriptions of teaching methods.

The Outdoor and Environmental Studies Teacher suggested presenting to student's CC data. According to this teacher, students understanding is enhanced when the "data is as raw and is as objective as possible" (Outdoor and Environmental Studies Teacher). The teacher believes that this approach enables students to draw constructive and action-oriented conclusions.

The Physics Teacher perceived CC education as a continuous process, beginning at a very young age. The teacher indicated that at the secondary level, particularly at the VCE level, students should be taught about rectifying the situation rather than learn the basics or the science behind CC. At this stage, students should apply critical and creative thinking skills to seek solutions. This would further lead to the action taking as citizens.

The Food Studies Teacher suggested inviting guest speakers, who are well equipped with CC knowledge to speak to students.

The Geography Teacher advocated using case studies, as the best method for teaching CC. The teacher suggested choosing authentic case studies with which students are already familiar with. By choosing examples from the local environment, students can develop a sense of belonging and responsibility toward protecting the local environment and finding solutions to CC issues. Furthermore, the teacher felt that the study of real-life issues enables students to develop their understanding of CC, as well as their values.

The findings reveal that the teachers present a rich tapestry of pedagogical approaches to teaching CC. Common to all the approaches is the emphasis on engaging students with CC in a meaningful way. For some of the teachers, this needs to lead to solution-finding.

Confidence in teaching

Teachers were asked as to what extent they felt that they were appropriately prepared to teach CC and how they felt about teaching CC in the classroom.

Two teachers, the Chemistry Teacher and the Food Studies Teacher reported that they lacked CC knowledge, and therefore, they did not feel confident in teaching CC. According to these two teachers, CC is not part of their study designs. Both the teachers stated that, should CC be integrated, without professional development it would be difficult for them to teach CC. It is important to note that the teachers' responses are at odds with the curriculum analysis presented in Part A. My analysis of the curriculum revealed that CC does appear in both of these study designs,

yet the teachers seemed unaware of its presence. I suggest that this may be due to the subtle, almost hidden ways in which CC is represented in the VCE curricula. One has to specifically search for 'signs of CC'. Those who are not experts in CC may easily miss these nuanced references to CC in some VCE study designs.

The Outdoor and Environmental Studies Teacher, the Physics Teacher and the Geography Teacher stated that they were knowledgeable about the topic and did not have many issues in teaching CC. They attributed their confidence to their prior knowledge and experience as teachers. Their confidence was expressed as follows:

> "I was pretty confident as I had some background knowledge and with the available resources and internet around..." (Outdoor and Environmental Studies Teacher).
>
> "I've got a broad understanding of CC…I guess my logical background makes me pretty well placed…" (Physics Teacher).
>
> "I've got a fairly good grasp on it…not bothered teaching... it's all interconnected…" (Geography Teacher).

The findings suggest that the teachers' confidence in teaching CC is inherently derived from their confidence in their content knowledge. This finding is consistent with multiple studies attesting to the role of content knowledge in developing teachers' self-efficacy (Sharp et al., 2016; Suharta, & Parwati, 2019; Swackhamer et al., 2009).

Understanding of CC concepts.

The participants were asked to share their perceptions regarding the main issues concerning CC, the main drivers of CC and, the impacts of CC.

In regard to the main issues concerning CC, the responses were highly diverse, reflecting the complexity and multitude of issues involved in CC.

The Outdoor and Environmental Studies Teacher discussed the tension and inter-dependence existing between science and policy. The teacher highlighted the fact that dealing with CC requires substantial investment in scientific research. However, to do this, there needs to be goodwill by the government to invest in research. Similarly, the Chemistry Teacher discussed the gap between CC science and political action, explaining that governments are refusing to act on scientific evidence.

The Physics Teacher perceived the public misunderstanding of science as a major issue. The teacher was concerned about the misinformation circulating within the public sphere. The Food Studies teacher expressed concern about CC denial and the lack of public awareness. This teacher found it concerning that regardless of the many expressions of CC around us, and many people do not make

the connections. Similar to the Food Studies Teacher, the Geography Teacher also expressed concern about the lack of public awareness. The teacher stated: “I think the biggest issue with that is making it (climate change education) accessible to the average layperson” (Geography Teacher). The teacher also highlighted that the challenges posed by CC are different at various scales and regions; explaining that “while in Australia, the problem expresses itself mainly as an environmental degradation issue, globally it causes climate refugees and global effect on tourism” (Geography Teacher).

When asked about the drivers of CC, all the participants agreed that CC is caused by human actions. However, the teachers’ understanding regarding the specific drivers were varied, yet highly accurate.

The Outdoor and Environmental Studies Teacher, perceived deforestation and greenhouse gas emissions as the main causes. The teacher stated: “Human actions definitely… damages done to our vegetation... harmful gas emissions” (Outdoor and Environmental Studies Teacher). Similarly, the Chemistry Teacher pointed out carbon emissions, as follows: “It has to do with the carbon emissions from my understanding” (Chemistry Teacher). Though the teacher’s response was scientifically accurate, the teacher highlighted his/her limited understanding as follows: “I am aware of such things as acid rain and the effect of carbon dioxide on the atmosphere and that’s pretty much it” (Chemistry Teacher).

The Physics Teacher elaborated on the sequence of events leading from energy production which omits carbon dioxide, and the role of transportation as a source of emissions. The teacher stated that, “no doubt that carbon dioxide is one of the nasty bi-products you’ll find in aeroplanes while driving your car… even electricity…the more we make people aware of it…the more we can push our politicians to actually do something about it” (Physics teacher). The Food Studies Teacher perceived consumption as the primary driver of CC. The teacher explained:

> We live a very fast lifestyle these days and its excessive… and lifestyle has become very disposable … you know we used to having lots of things that are easily disposed of … but you can’t … and are not recyclable as well ... I think we are using … we are consuming too much energy and too much water… too much natural resources (Food Studies Teacher).

The Geography Teacher seemed to provide the most comprehensive response. The teacher identified greenhouse gas emissions, population growth and deforestation as major drivers. This was stated as follows: “Human activity … without a shadow of doubt …deforestation is the most common one … increase in greenhouse gases from factories vehicles harming our atmosphere… as

the population increases the number of activities also increase … which eventually harm our environment" (Geography Teacher).

The teachers' responses seem to reflect the scientific community's understanding to a large extent. The IPCC, which is the peak authoritative body in terms of CC science, identifies the main drivers of CC, as economic growth and population growth. These, in turn, drive anthropogenic greenhouse gas emissions growth (IPCC Synthesis Report, 2014c, p. 4). The greenhouse gases are produced through fossil fuel burning (energy production, industry, transportation); and, land-use changes (urbanisation, deforestation, agriculture) (IPCC Synthesis Report, 2014c).

When addressing the impacts of CC, the teachers described a long list of impacts, which seemed well connected to the drivers mentioned above. These impacts include (i) extreme weather events such as heat extremes, heavy downpours, flooding, cyclones, droughts etc. (Outdoor and Environmental Studies Teacher, Physics Teacher & Geography Teacher); (ii) increased temperatures (Chemistry Teacher & Food Studies Teacher); (iii) melting glaciers and sea-level rise (Food Studies Teacher & Geography Teacher); (iv) effects on food production (Outdoor and Environmental Studies Teacher & Chemistry Teacher); (v) species extinction (Food Studies Teacher); (vi) landscape changes (Food Studies Teacher) and, (vii) climate refugees (Geography Teacher).

In addition to identifying the impacts of CC, the Physics Teacher continued to establish links between the impacts of CC, the environment and people's survival. For example: "Environmental impacts … more severe weather events... so the impacts are… more severe weather events where people die due to the heat extremes…things like that… more floods…more cyclones" (Physics teacher).

Interestingly, the teacher seemed doubtful of the CC projections. The comment was stated as follows:

> As the general comment most of the climatologist are telling us that there is so much increase in temperature at the moment… so if you work out the extremes… they aren't real… there seems to be some very slight increase in the temperature of the Earth… so that's the concern (Physics Teacher).

This comment suggests that the Physics Teacher is unsure about messages from climatologists. My understanding of this comment is that it does not account for the difference between the terms *weather* and *climate*. While for the *weather* (which describes local transient conditions), the temperature rise of 1 or 2 degrees Celsius is meaningless and cannot be regarded as extreme, for

climate (which describes long-term atmospheric patterns), such increase may have dramatic effects on local weather.

The Geography Teacher stood out in the comprehensiveness of the impacts described. The teacher was able to form connections that go beyond the impacts of CC on the weather, people's lives and livelihood. The teacher described how environmental disasters might lead to displacement and CC refugees; that CC is causing sea-level rise, rising temperatures, climate refugees and melting glaciers. The teacher further described the complex connections between glaciers' melting and loss of cultures and traditional sources of livelihood, as follows:

> The Jakobshavn in Greenland is producing [melting glacier] triple of what it used to just 8 years ago … and that's causing you know… the desalination of the bay around it and its … you know all these people are now having to completely change their lifestyles so … so you've gone from traditional agricultural hunters and gatherers to than… now they have to do tourism because people wanna come and see it (Geography Teacher).

Overall, the analysis of the teachers' perceptions regarding the main issues concerning CC, the main drivers of CC and the impacts of CC, reveal varying levels of depth and breadth of understanding and engagement with CC issues. While all the teachers clearly perceive the problem of GHG emissions, their understanding of the immense complexities and interconnectedness of CC processes and impacts vary substantially.

CC topics that are being taught.

My analysis revealed that CC appears in 10 curriculum subjects. When asked about the subjects in which CC is taught at a VCE level, the three teachers who responded to the question, identified their three subjects: Outdoor and Environmental Studies, Physics and Geography. These three subjects are taught in the school, and the teachers were familiar with them. As noted above, Chemistry wasn't mentioned regardless of the fact that it is taught at the school and was identified in the Part A curricular analysis as a VCE subject that addresses aspects of CC.

The Outdoor and Environmental Studies teacher explained that "It's not a significant extent, to be honest, basically a page or two in the textbook…" (Outdoor and Environmental Studies Teacher). The Outdoor and Environmental Studies Teacher explained that teaching CC requires a maximum of two periods which is equivalent to 120 minutes. The teacher explained that students have to analyse the impacts of social and political debates; water management, renewable energy and CC, on societal relationships with the outdoor environment (Outdoor and Environmental Studies Teacher).

The Physics Teacher indicated that CC is taught as part of the Earth's systems; that this part of the subject basically describes the physics of what is happening within the Earth's systems and what causes CC is natural and human actions. The teacher stated that the discussion is anchored around the physics of the mechanisms of Earth heating up and heat getting trapped in the atmosphere; carbon dioxide emissions and general mechanisms that happen without climate change (Physics Teacher). The teacher also stated that approximately four weeks are devoted to teaching CC.

The Geography Teacher explained that CC is integrated across the teaching of the Year 11-12 geography subject, in all four units: natural hazards, tourism, changing landscapes, and population. The teaching addresses the causes, impacts and strategies to overcome the challenges posed by CC. According to the teacher,

> Climate change is discussed at a base level, looking at how it affects natural hazards… effects of climate change on tourism and how tourism affects climate change… unit 3 we definitely look at it more… for example we do melting glaciers and ice sheets and obviously the main driver for that is climate change … as a result of human activity but also glacial maximums … looking at change over time… how climate change was affecting then, how we are affecting climate change which then contributing to landcover change … when we look population, we look at population movement and climatic refugees (Geography Teacher).

Within these two years of VCE Geography study, approximately 14 weeks are directly devoted to teaching CC, however, teaching about CC permeates all the learning in the Unit.

Overall, based on the views expressed by the teachers, CC is taught as a subtopic or in conjunction with other topics in Outdoor and Environmental Studies and in Physics. However, in Geography, CC is addressed holistically, including causes, impacts and strategies for adaptation and mitigation.

Integration of CC education in and between disciplines.

The participant school abides by the Victorian Curriculum and Assessment Authority (VCAA) Curriculum and guidelines. However, to some extent, teachers and schools are free to make their own strategic decisions regarding the implementation of CC. When asked whether CC is integrated across the curriculum, or as a subject on its own, the teachers responded as follows:

> It's definitely not a subject on its own, … I haven't come across it as a topic in science and the first time I've seen is in OES (outdoor environment studies) ..." (Outdoor and Environmental Studies Teacher).
>
> "Not that I am aware of" (Chemistry Teacher).

> "Sporadically taught in science and that's it, as far as I am aware, I don't interact with the humanities very often, so I am not aware what they are doing…" (Physics Teacher).
> "I don't really know, I assume they do in sciences but because I don't teach sciences I don't know…" (Geography Teacher).

The above quotes provide a clear indication that CC education is not taught as a subject on its own, rather implemented within various subjects. The responses reveal that in regard to CC, teachers seem to work in silos. The teachers demonstrated very limited knowledge of how and to what extent CC education is implemented at the VCE level outside their subjects. This indicates that there is a lack of collaboration among CC educators with regard to CC education.

The strategies that teachers use when teaching CC.

Initially, teachers were asked for their opinion regarding best-practices in teaching CC. Further in the interview, the teachers were asked to describe the strategies and pedagogies that they actually use in their routine practice of teaching CC. The findings reveal that there are some gaps between the practice and the 'best-practice' ideal. These gaps could potentially point to the challenges posed by the VCE standardised external assessments.

The Outdoor and Environmental Studies Teacher who initially highlighted the importance of presenting students with CC data, when describing the actual practice, mentioned two practices. The first is the use of case studies in order to capture students' interest in the topic. The second is the use of past exam questions as a teaching resource. The teacher explained that preparing students for the exams forms a major part of the teaching. The teacher stated: "a lot what I do is about preparing students for the SAC (School Assessed Coursework) so even past exam questions as well" (Outdoor and Environmental Studies Teacher).

The Physics Teacher who initially highlighted the importance of applying critical thinking and creative skills to find solutions to the problems, when describing the practice, highlighted the use of imagery and diverse teaching strategies. The teacher uses an online program called *Edrolo*, which, according to the teacher "has great videos and, informative and engaging presentations" (Physics Teacher). The teacher also uses textbooks, handouts, YouTube videos, quizzes as well as going through past VCE exam questions. The teacher also mentioned the importance of using diagrams and pictures to teach CC. The teacher explained: "I try to do it very pictorially because the kids here respond well to wall pictures and images, showing the heat waves and things like that" (Physics Teacher).

The Geography Teacher who initially advocated the use of case studies, reported the application of this strategy in practice, as well as using diverse strategies in the teaching of CC. The Geography

Teacher stated that “anything that I can use to teach it all”. In addition to case studies, the teacher uses textbooks, the Internet, research papers, videos, YouTube, mind-mapping and structured questions. The teacher also uses hands-on demonstrations, such as “demonstrations with jelly, crushed ice to look specifically at glaciers” (Geography Teacher).

The comparison of teachers’ perceptions regarding best practices in teaching CC and the actual teaching strategies which they apply reveals some of the challenges faced by teachers when they attempt to apply what they believe to be ‘best-practice’. Two of the three teachers who responded to this question highlight the use of past VCE exams for preparing students for testing. It seems that this effort sets limitations to what teachers can do. However, it is interesting to note that the Geography Teacher did not mention the VCE exams, but rather emphasised the diversity of strategies, including hands-on activities.

4.2.2 CC conceptualisation by students

Students were asked to share their perceptions regarding the following aspects of CC: (i) CC as a major phenomenon of our time and their interest in studying CC; (ii) understandings about CC: Causes and issues; (iii) the CC impacts on everyday life, on societies, and the world; and (iv) the sources of information that inform students learning of CC. The seven student participants’ responses to these issues are described in what follows.

Perception of CC as a major phenomenon of our time and interest in studying CC

The students were asked to discuss their views about CC, the degree of CC’s importance, and their interest in learning about CC.

All seven students perceive CC as a major threat of our time. Students expressed the view that CC is progressive over time and accelerating at an increasing speed. For example: Student 3 stated that the threat is “very high … I think that it’s important” (S 3). Student 7 said that. “It’s happening quite fast…the world keeps getting hotter and hotter”. Student 5 rated the threat as “10 out of 10”. Most students described the nature of the threat as a powerful force that may destroy the Earth. Student 2 stated: “just eventually like there will be nothing left”. Similarly, Student 3 said that “if we don’t do something about it now, we could be potentially be endangering our Earth for the future and for our children and so on …Pretty much destroying us”; Student 7: “if we don’t try to do something about it now then the future… what’s the life gonna be like then”; Student 2: “Dramatic changes in climate” (S2).

The students were struggling to provide more specific details regarding the nature of CC and its impacts. Student 1 was able to identify broadly that CC is impacting the environment, as follows:

"It's destroying our environment" (Student 1). Student 4 broadly identified impacts on changing the land and the way we live. The student stated: "Heavily contributing to the changing land and the way in which we live our lives" (Student 4).

When asked about their interest in learning CC, students demonstrated a strong desire to learn about CC. The students expressed the view that not enough time is allocated for teaching about CC. They claimed that school does not teach them enough. Student 2 stated: "We have just learnt the basics"; Student 3 stated that "I feel like we haven't learnt a lot about it".

The students assessed their understanding of CC as limited and inadequate. When considering what particular CC information is missing from their understanding, the students focused mainly on mitigation. Student 1 asked "How do we…do we prevent this thing from happening?"; Student 5 expressed the desire to learn "more about how we fix it".

Overall, CC is perceived by students as a major threat that poses a danger to their future. They all expressed a wish to learn more about CC and complained about the inadequacy of their school CC education.

Understanding CC: Causes and issues

When asked to consider the causes of CC, all seven students identified human actions as the main cause. In this respect, the students' responses echo their teachers. With further probing, the students identified the more specific causes, as follows: Burning of fossil fuels (Students 1, 2, 3 & 5); release of GHG (Students 2, 6 & 7); pollution (Students 4, 5 & 7) and, modes of transport (Students 4 & 7). For example, Student 7 explained the causes as "Human processes and stuff like the burning of fossil fuels and air pollution from like planes…greenhouse gases… all of that". Student 1 was the only one of the seven who was able to identify population growth as a cause. This student commented in the context of discussing world impacts that "I think population…that's impact on the world, I guess" (Student 1).

When considering the main CC issues, the students were struggling to provide more specific details. Student 6 mentioned meeting the needs of climate refugees while Students 1 and 2 mentioned that not much is done to address climate change.

The responses from the students also demonstrated misconceptions. This was evident through explanations such as "dramatic changes in weather" (S2) and "heating of the ozone layer" (S3) that were used while describing CC.

The results indicate that students express a clear understanding of humans' responsibility for causing CC. However, their responses do not present an organised set of concepts related to CC. Rather their conceptualisation of CC seems fragmented; composed of incomplete concepts.

The impacts of CC: on everyday life and broader impact

The students were asked to consider the impacts of CC both in everyday life and regarding broader impacts. In regard to the everyday impacts, only one student, Student 3, articulated a personal connection to everyday CC impacts, through the comment that "we are heating up and that it is affecting us". Other students did not relate such impacts to their own lives, but rather to the lives of people elsewhere. Student 6 stated: "On everyday life … I don't see a great impact compared to where we live".

When considering the broader multi-systems impacts of CC, the perceptions of the students varied. Three Students (1, 2 & 5) were able to relate the impacts of CC at the one order system level; that is, impacts in one system causing impacts in another system. The other four Students (3, 4, 6 & 7) perceived CC impacts more broadly as involving multi-system impacts with at least three systems (i.e. two order system impact) implicated. This systems thinking in relation to CC is indicated through the following students' quotes:

(a) One order system impact identified by the students:

Student 1 identified population changes as an impact of CC. The student stated, "population issues … especially… for the coastal countries". Similarly, Student 2 identified loss of produce due to dramatic changes in the weather pattern as an impact. Student 5 also identified changes in weather patterns from CC, as follows: "climate change could be causing like … bad weather pattern like storms and stuffs like that … causing things to go wrong."

(b) Broader, multi-system impacts identified by the students:

Student 3 explained how CC impacts sea level rise, and this in turn impacts agriculture and livelihood.

> "I think the people living on the coastal countries will probably be most affected … by the area by (the) obviously there will be less land for them…like earlier I was saying for to grow crops and stuff… less produce less area for them to build to expand and less infrastructure" (Student 3).

Student 4 noted: "I think if we look at a country like Greenland… their ice melting it affects their everyday life …they can't do things which they used to do". The student further explained that CC also causes land changes, which in turn, impact our everyday life. In this regard, the student stated: "heavily contributing to the changing land … the way in which we live our lives". Student 6

mentioned temperature rise and prolonged droughts, as follows: “temperature might increase … and so drought might last longer …that’s the only thing”. In the first order impact, Student 6 identifies CC as causing temperature rise. In the second order impact, the temperature rise is identified as a cause of droughts. Similarly, Student 7 stated temperature rise and impacts of global warming. When explaining, the student said, “it is changing the world… as in like these places are very cold are getting hotter… the summers do get hotter in recent years … so ice caps melting and stuffs like that…. like the uprising sea levels”. Here Student 7 seems to identify a chain of cause-effect events. The first order impact is the temperature rise. This in turn causes ice caps to melt, and this in turn causes sea rise.

Overall, based on the views presented by the students, the students seem rather safe in their immediate surroundings. However, the students have demonstrated a fair understanding of the complex nature of CC. The students were able to describe the ‘domino effect’, in which CC impact in one system causes impacts in other systems.

Sources of information that influence students’ learning of CC.

Finally, students were asked to describe the sources of information that inform their understanding of CC. In particular, to describe the topics covered in class and, the number of classes (periods) attributed to CC education.

Five students stated that the sources of CC knowledge were from the subjects they are studying: from teachers and resource materials such as textbooks. According to the students, the subjects that contained CC information are: Geography and Outdoor and Environmental Studies. However, not all students study these two subjects. This may explain why two students could not recall any CC education at school. For example, Student 1 noted: “physics is like more concepts …that’s physics related not like climate”. Yet all seven student participants were involved in CC education according to the VCE study design analysis from Part A.

The students described which CC topics they learned in the different subjects, as follows: In Geography - melting of ice sheets and glaciers, deforestation and desertification. In Outdoor and Environmental Studies - fossil fuels, renewable energy, rising sea levels and glaciers. The participants estimated that approximately six lessons in Geography and two lessons in Outdoor and Environmental Studies were dedicated to CC. In addition to learning at school, the students mentioned the media - Internet, television and newspapers - as sources of CC information. The students identified these media information sources as playing an important role in complementing students’ CC school education.

The findings regarding the sources of students' CC information suggest that students identify CC as being taught only in two VCE subjects, Geography and Outdoor and Environmental Studies. This perception differs from that of the teachers, who reported that CC is also taught in Physics. These student perceptions of CC-including VCE subjects also do not align with the Part A curriculum analysis findings, where other subjects were also identified as including CC education. Additionally, the students reported that the media plays a major role in informing them about CC, possibly filling a void in their school education regarding CC. This finding is somewhat disconcerting, due to the unreliability and at times predatory nature of media sources.

4.3 Summary of findings

In summary, the findings of this study addressed CC education at three levels: the VCE curriculum, the teaching of CC, and students' learning of CC. The examination of the curriculum revealed that CC was addressed only in 10 subjects. Its presence in these subjects was examined in relation to the conceptualisation of CC characteristics, the topics taught and the integration of CC across the curriculum. In regard to CC conceptualisation, it was revealed that none of the ten study designs presents all three characteristics of CC, which involves: (a) inherent complexity; (b) a level of uncertainty; and, (c) human action. Similarly, none of the study designs addressed CC comprehensively through the five constituents of science, environment, society & culture, policy, and economy. In regard to cross-curriculum integration of CC education, this is not addressed in any area of the VCE curriculum. There are no cross-disciplinary links indicated between the study designs indicating that the study designs seem to operate in isolation or in silos. Within the study designs themselves, CC information appears fragmented. Essentially, none of the VCE study designs addresses CC holistically.

In the examination of CC education implementation through the case study of VCE studies in one school, the VCE teachers' perspectives reveal that while all teachers were unanimous regarding the importance of teaching CC, they varied in their perceptions regarding most other aspects of CC education. The teachers' knowledge of CC varied, and this appeared as a determining factor with regard to their confidence in teaching CC and the extent to which they implemented CC in their classrooms. At the one end of the scale, the geography teacher was highly knowledgeable and confident in their knowledge, and accordingly, this teacher implemented CC beyond the scope required by the curriculum. At the other end, the chemistry teacher expressed limited confidence in teaching CC and limited CC knowledge, with the apparent limited implementation of CC education. Similar to the curriculum, the teachers also seemed to work in silos, with no apparent collaborations among them with regard to teaching CC. The results also indicate that there is no formal structural

support for teaching CC. The only determinant as to whether the teachers will teach CC or not, was their own personal background which impacts their self-efficacy. The curriculum does not provide any support in the form of detailed instructions, and there does not seem to be any CC professional development or teamwork at the school that could potentially support teachers. There are, of course, various supportive resource materials available for teachers to assist them in teaching about CC from a wide range of local and global sources (see for example those included in the literature review), including in some VCE studies complementary 'Advice to Teachers' documents. However, the use of these support resources is at the discretion of the teacher which further reinforces the finding that CC education in the VCE is largely driven by teacher preferences, not the curriculum. It must also be acknowledged here that secondary teachers commonly teach out-of-field. That is, they take on the role of teaching subjects when needed to in their schools that are out of their particular field of speciality. This may mean that teachers who are known in their school as the 'X Subject' Teacher, may not have deep and/or recent discipline knowledge to draw upon. Again, highlighting the need for formal CC education support for teachers.

The examination of students' conceptualisation of CC, echoes their teachers to some extent. They too perceive CC as a major threat and think that it should be taught at school. They found their school CC education insufficient. Similar to most of the participant teachers, the students also presented fragmented knowledge about CC. However, some students were able to successfully demonstrate its complexity nature. Finally, it was found that students rely on the media for the CC education they need. Overall, it seems that the deficiencies identified in CC education at the VCE curriculum level seem to cascade over to the teaching and learning of CC, leaving teachers and students to reason through and develop their understanding of CC through self-reliance and informal learning. The following chapter discusses some of these key research findings.

Chapter Five
Discussion and Conclusions

5. Introduction

This study put forward the aim to examine the conceptualisation of CC education within the VCE curriculum and its implementation at the upper-secondary school level, in the state of Victoria. The study was guided by the following questions: How is CC represented and conceptualised in the VCE curriculum study designs for years 11-12? How is CC education conceptualised and implemented in years 11-12 from the teachers' perspectives? And, how is CC education conceptualised by Years 11 and 12 students studying the topic? These three questions address the

three interconnected levels of curriculum conceptualisation and delivery: the formal intended curriculum (i.e. the curriculum that ought to be taught as directed by the official VCE study designs); the implemented curriculum, as applied by a small group of five upper secondary teachers in one secondary school in Victoria; and, the attained curriculum, as perceived by seven of these teachers' students (Van Den Akker, 2004). By examining these three levels of CC education, I was able to draw some meaningful insights into the ways in which CC education is interpreted and enacted, as it makes its way from the official documents to the learners.

This Discussion and Conclusions chapter is organised according to the three main themes that arose from the findings. The first is the interpretation and translation of the formal curriculum within the teaching and learning of CC. The second part addresses the enablers of CC education, primarily the structural support provided for teaching CC. Finally, I address schools' failure to equip students with appropriate CC knowledge. This final chapter concludes by outlining the implications and limitations of the study.

5.1 CC curriculum interpretation and translation into teaching and learning

Here, I discuss three aspects of CC curriculum interpretation and translation within the Victorian VCE. These include: CC integration within subjects, the topics taught and learnt, and CC conceptualisation.

CC integration within the VCE subjects

Out of the 96 VCE subjects, using the indicative key terms derived from a systematic analysis of the IPCC reports, CC was found to be present in only 10 of the study designs. Each of these study designs in turn addressed CC without connection to other study designs, effectively creating a curriculum silo effect. When it comes to CC education, the VCE subjects do not seem to coordinate with each other. Each subject addresses CC topics within a narrow discipline-based focus, disregarding the other subjects, and with no overview of what needs to be included regarding CC education. This lack of integration and coordination leads to some CC topics being missed-out all together from all 10 VCE subjects, while other topics are repeatedly appearing. For example, the discussion of ethics in relation to intergenerational and intra-generational climate justice was missing in all ten CC-containing study designs, while CC mitigation and adaptation seemed to reappear in most of the study designs. Overall, it seems that none of the ten study designs takes complete ownership of CC education, thus leaving CC marginalised, and often addressed in a tokenistic way. These findings regarding CC marginalisation within the curriculum were found in other studies examining different countries' curricula. For example: in France (Arnould, 2013),

Canada (Field et al., 2020) and United Kingdom (Bloom, 2019). Additionally, Monroe et al. (2019), in an attempt to identify effective CC education strategies through a systematic review, indicated that none of the educational programs reviewed intentionally approached CC from both social and science disciplines; suggesting a complete lack of a multi/inter/cross-disciplinary integration approach.

The lack of integration and the silos approach to CC reveals itself once again downstream from the formal curriculum. The teachers too taught CC in silos. This was highlighted by the participant teachers who indicated an absence of knowledge about the CC curriculum and teaching beyond their own subject curriculum and their own class activities. The lack of shared understandings and collaboration between teachers was demonstrated in many ways. For example, the teachers expressed highly diverse views in regard to CC pedagogy and content. Also, the analysis of their perceptions regarding CC issues, drivers and impacts, revealed varying levels of depth and breadth of understanding and engagement with CC issues. These findings suggest that little to no conversations take place among the subject teachers regarding CC education. It appears that this lack of coordination between subject teachers is not unique to Australia. Arnould (2013) reports that in France's secondary schools, aspects of CC are taught in the separate subjects of geography, the life sciences, earth science, economics and technology. Clearly, a strategy to attend to the cross-disciplinary aspects of CC and bring the various disciplines to work together in educating about CC has not been realised (Arnould, 2013).

The examination of students' content knowledge once again presents a reflection of the silo approach and the fragmentation of CC. Students in the study were not able to present organised, cohesive understandings of CC. Particularly worrying was the finding that students obtain much of their CC knowledge from the media. This suggests that schools are not adequately equipping students with the required knowledge about the biggest threat of our time, climate change.

Overall, the findings reveal that the VCE subject curricula address CC in a disconnected and fragmented way. This cascades on to the teaching and learning of CC, both of which are characterised by a lack of coherence.

CC topics taught and learnt

In the analysis of the VCE study designs, I examined CC topics according to five broad areas of disciplinary affiliations: science, environment, society & culture, policy, and economy. The findings reveal that none of the study designs addresses all five areas. Only four study designs address four areas out of the five, and the remaining study designs address between one and three of the disciplinary affiliations. Here I ask: Are the scope of CC topics within the disciplinary affiliations of

science, environment, society & culture, policy and economy similarly aligned when translated and interpreted by the teachers and their students within the VCE subjects? Does the same pattern of siloing and fragmentation of CC evident in the curriculum between VCE subjects extend to the connected disciplinary affiliations of science, environment, society & culture, policy, and economy? This pattern of disciplinary affiliations seen in the curriculum suggests that the CC topics taught and learnt will focus on only the disciplinary affiliations that match the subject experienced. Meaning that a student studying, for example, VCE Environmental Science will only be successful in articulating CC topics about science, environment, society & culture, and economy, in alignment with this study design. Whereas a student studying, for example, Physics, will only be successful in articulating CC topics in science, in alignment with the physics study design. To reveal the patterns of translation and interpretation of CC disciplinary affiliations and topics in the teaching and learning within the VCE at the case study school, I organised the findings into a comparative table. Table 4 reveals notable, non-linear changes along the curriculum pathway from the intended to the attained curriculum with regard to the understanding and conceptualisation of CC.

Table 4. CC topics and CC characteristics along the curriculum pathway - from the study designs, to the teaching, and to the learning

VCE subject	CC disciplinary affiliation by curriculum topics	Scope of CC teaching	Students' Knowledge of CC topics and CC characteristics
Chemistry	Science	The teacher indicated that CC is not part of their subject's study design and they lack sufficient CC knowledge to teach CC.	*Student 1*: CC caused by the burning of fossil fuels; population growth enhances CC; CC destroys the environment. *Student 6*: CC caused by the release of GHG; CC causes climate refugees **= multi-system (complexity) thinking**:
Food Studies	Environment Society & culture Economy	The teacher indicated that CC is not part of their subject's study design and they lack sufficient CC knowledge to teach CC.	*Student 2*: CC caused by burning of fossil fuels and release of GHG. **= multi-system (complexity) thinking**:
Geography	Environment Society & culture Economy	In Years 11-12, approximately 14 weeks are directly devoted to teaching CC. However, teaching about CC permeates all the learning in the Unit. This includes: Natural hazards, tourism, changing landscapes, and population. The teaching addresses the causes, impacts and strategies to overcome the challenges posed by CC	*Student 3*: CC caused by the burning of fossil fuels *Student 4*: CC causes changes in the land and the way in which we live our lives; Certain modes of transportation enhance CC. *Student 7*: CC caused by the release of GHG; CC enhanced by modes of transport; 'we are heating up, and it is affecting us.' *Student 3 misconception*: 'Heating of the ozone layer'. **= multi-system (complexity) thinking evident for all these students.**
Outdoor and Environmental Studies	Science Environment Society & culture	In Years 11-12 the scope of contents covers "basically a page or two in the textbook" (Teacher) Learning activities consider social and political debates in relation to water management, renewable energy and CC, and the society's relationships with the outdoor environment.	*Student 5*: CC caused by the burning of fossil fuels
Physics	Science	In Years 11-12, approximately four weeks are devoted to teaching CC. The topics address: • What is happening within the Earth's systems and what causes CC; • natural and human actions; • the physics of the mechanisms of Earth heating up and heat getting trapped in the atmosphere; • carbon dioxide emissions and general mechanisms that happen unrelated to CC.	*Student 1*: CC caused by the burning of fossil fuels and population growth; CC destroys the environment.

Examination of Table 4 clearly reveals that teachers are not passive transmitters of the curriculum, and students are not passive absorbers. The findings clearly demonstrate what constructivist theories tell us about knowledge and its construction (Oliver, 2000) in that, both the teachers and the students make their own interpretations about CC topics to develop their own understandings.

The examination of the teachers' interpretation and translation of the curriculum reveals that each of the teachers does this in their own unique way, according to their own personal world view and content knowledge. The Chemistry study design covers the science aspects of CC according to the key CC indicator terms in Part A analysis. However, the Chemistry Teacher did not recognise the presence of CC in the curriculum. Similarly, the Food Studies Teacher did not identify the environment, society & culture, and economy aspects of CC within their study design. Both teachers indicated a lack of confidence in their CC content knowledge and that they are not teaching CC. In contrast to these teachers, the findings show that while the geography curriculum addresses only three disciplinary areas of CC, the Geography Teacher addresses all five. This teacher devotes 14 weeks to teaching CC specifically and continues to address CC throughout every topic they teach, which is well beyond the curriculum's intention. In between these two extremes, the study finds the Outdoor and Environmental Studies Teacher, who reports that while the textbook devotes only one to two pages to CC, extends somewhat beyond this scope, yet still to a limited extent regarding a full cross-disciplinary exploration of CC. The Physics Teacher also seems to teach the curriculum as intended, focusing only on the science aspects of CC.

The examination of the students' responses once again reveals that learning is complex, and it is influenced by many factors in which the teacher is only one of them. This is clearly demonstrated in the students' indications of their CC understandings. For example, while the Chemistry Teacher reported that they do not teach CC, two of the students studying in this class demonstrated some CC knowledge. On the other hand, while the Geography Teacher reported extensive coverage of CC in their classes, one of the students in the class, Student 3, presented a misconception regarding the ozone layer.

Overall, the comparison of CC topics at the three levels of the curriculum pathway from the intended, formal curriculum, to the teaching and to the learning, does not reveal any identifiable trend. The scope of content neither became diluted nor intensified but rather portrays some randomness. This randomness seems to be derived from idiosyncratic factors such as the Geography Teacher's passion for CC, or students' personal interests.

Additionally, I suggest a key structural characteristic of the VCE itself is a major factor influencing this seemingly indiscriminate CC education implementation. I suggest the inadequate CC education

in the VCE is a reflection of the VCE examination process. As the university entry measure and school exit qualification in the state of Victoria, the VCE implementation tends to be high-status testing focused. The VCE study designs indicate that CC is only to a limited extent, or not at all, a topic that is being examined, and therefore it is not considered as sufficiently important to generate rigour and consistency in teaching and learning. Ross (2000) in his analysis of curricula has demonstrated how curricula tend to form hierarchies in subjects, in which those topics that are examined 'count' as important and those that are not, become marginalised within the curriculum (Ross, 2000). The limited representation of CC within the individual study designs, and the VCE overall, gives an implicit message about the importance placed on CC education in the VCE. Aligned with this is the inherent customising of curriculum implementation teachers undertake according to their context, background and confidence with topics. For teachers such as the geography teacher in this study who are passionate, knowledgeable and confident about teaching CC education, the implementation of CC education is strongly represented in their teaching.

The implication of this characteristic is that for CC to be taken seriously in the VCE, a top-down approach needs to be implemented. This requires much more rigour in the content development of the curriculum subjects and in their assessments. Allied to this is the strengthening of teachers' CC education capabilities which is discussed in more detail later in this chapter.

CC conceptualisation

The literature review identified three fundamental aspects that characterise CC as a body of knowledge. These are the inherent complexity of CC, a level of uncertainty, and the involvement of human action. The examination of the study designs revealed that none of the study designs conceptualised CC comprehensively, with the Chemistry, Physics and Systems Engineering only including CC topics without consideration of any of the three fundamental characteristics of CC. When considering the extent to which teachers and students expressed an understanding of these fundamental CC aspects, the findings suggest that, once again, teachers' understanding does not necessarily reflect the curriculum.

The examination of the teachers' perspectives reveals varying levels of depth and breadth of understanding and engagement with the characteristics of CC. All of the participating teachers acknowledge that the climate is changing and believe that humans are at least, in part, contributing to the change. Additionally, they all perceive CC as one of the most pressing issues that humanity faces in the present time and support the need to teach CC to secondary students as a high priority. The teachers were able to demonstrate understanding regarding the complexity and the uncertainty related to CC, and to identify the drivers and describe the impacts of CC. They were able to relate to

more than one order system involvement in CC, confirming conceptualising CC as complex. However, it was evident that at least one teacher had only a very limited understanding of the complexity and the uncertainty surrounding CC. And, surprisingly, a teacher with a science background appeared to distrust the science of CC projections and demonstrated a lack of understanding regarding the fundamental concept of temperature measurement in the context of climate; confusing local temperature rise related to weather, with global temperature rise related to climate (Nicholson, 2017; Herman et al., 2015; Boon, 2014). Teachers with varying levels of depth and breadth of understanding and engagement with the characteristics of CC appear to be widespread. According to Kwauk & Winthrop, 2021, and Youra, 2020 teachers is the United States, United Kingdom and Europe acknowledge that there should be more teaching on CC however only a handful of teachers fully understood the scientific consensus on CC.

In contrast to the other participants, the Geography Teacher's CC conceptualisation is exceptional in the comprehensiveness of the CC issues described. The teacher is not only able to form connections that go beyond the impacts of CC on the weather, people's lives and livelihoods, but further describes the complex connections between glaciers' melting and loss of cultures and traditional sources of livelihood.

The examination of the students' responses reveals that the students are receptive to the teaching of their individual teachers. The students in this study, to some extent, are echoing the voices of their teachers in regard to CC conceptualisation. Similarly to their teachers, the students too, rate CC as a serious issue, caused by human actions, and that forms a significant threat in our time. Most of the students are able to demonstrate understanding regarding CC complexity and the levels of uncertainty involved in CC projections, however, this was only to a limited extent. Some students indicated CC understandings that could not have been developed from their VCE classes according to what the teachers reported teaching. This indicates other, possibly less reliable, information sources such as the media (as the students indicated) are influential CC education actants. Previous studies have revealed similar results. For example, Johnson (2019) in the United States and Nugent, (2021) in the United Kingdom, reported that there is no core curriculum that ensures all students receive the knowledge and skills required to fully understand CC. This is concerning if students are developing misconceptions, as evidenced in this study, and clearly indicates a need for some curricular revisions to strengthen CC education in the VCE study designs.

In summary, the findings reveal that with regard to CC integration within the VCE subjects, there is a lack of integration across the subjects. Within the subjects, the content knowledge is fragmented and de-contextualised from the comprehensive aspects that make up CC. Thus, the curriculum does

not support the development of a coherent understanding of CC. The examination of the CC topics taught and learnt reveals that teachers and students are unable to rely on the curriculum to guide their knowledge construction. That CC knowledge construction in this case study of year 11 and 12 VCE teaching and learning presents itself as idiosyncratic; not a strongly structured process.

Similarly, the findings regarding CC conceptualisation reveals that the incomplete conceptualisation of CC by the curriculum cascades down to teachers and students, and leaves both teachers and students to their own devices in regard to developing a comprehensive conceptualisation of CC.

5.2 Structural support for teaching CC

The study's findings reveal that there is no formal structural support for teaching CC. The curriculum does not provide support in the form of detailed instructions, and there are no professional development or teamwork opportunities at the school that could potentially support teachers regarding CC education in the VCE. The findings reveal that some of the teachers felt that CC is either not addressed sufficiently, or not at all. They expressed confusion with regard to CC content that needs to be taught. This lack of clarity was reflected in the teachers' responses in many ways. For example, the Chemistry Teacher and the Food Studies Teacher thought that CC was not part of the study designs, though, in fact, it was according to the CC keyword matching found in the part A analysis. The Outdoor and Environmental Studies Teacher and the Physics Teacher highlighted that CC did not have a precise topic or theme but was taught in conjunction with other topics. Similarly, when it came to pedagogy, the teachers suggest various pedagogies based mainly on their usual teaching practice. None of the teachers were able to demonstrate their knowledge of CC as an outcome of professional development workshops, curriculum guidance or other supporting materials. This confusion seems to affirm previous studies examining CC integration in various subjects. For example, in a study of German chemistry teachers, Feierabend et al. (2010) found that the teachers were unable to establish connections between CC issues and the discipline-based subjects in which CC was integrated. The only determinant as to whether the German teachers in Feierabend et al.'s study will teach CC or not was their own personal background which impacted their self-efficacy. Johnson (2019) indicates that some teachers believe CC is still particularly challenging and that there are insufficient resources to incorporate it into their curriculum. Similarly, the findings in this study indicate the VCE teachers also needed to rely on their personal background as a resource for supporting their CC teaching. Other studies found out that time constraints are an issue when it comes to addressing CC implementation (England, 2020; Pitman, 2019). Teachers are eager to implement CC but are already under pressure from an

overcrowded curriculum and even more pressure to teach children in a way that ensures the best exam results (England, 2020; Pitman, 2019). The teachers in this study held to their usual teaching practices - whether this was due to time pressures that did not allow them to develop their CC education capabilities was not clear from this study, but from others' findings this is noteworthy and, in conjunction with the acknowledgement that the VCE curriculum and final examination system necessitates teachers to teach to tightly prescribed discipline requirements, suggests an avenue for further research.

Overall, the findings suggest that the combined effect of a curriculum that is too broad, unclear and not prescriptive enough in relation to CC, together with the lack of support resources to assist teachers in teaching CC, limit effective CC education implementation in the VCE in the case study school. These findings from one Victorian school give some basis to suggest that the limited uptake of CC education in the upper secondary is not an isolated event. It is highly likely that across Victoria, CC education almost solely relies on the teachers' personal background and is unlikely to be taught if the background CC knowledge is lacking. This is mainly due to the lack of governmental structural support for CC education in the VCE.

5.3 Schools' failure to equip students with appropriate CC knowledge

For many young people around the world, it is an unquestionable fact that CC poses a major threat to their future. The reality of CC clearly confronts us now and is inescapable. Here in Australia, we have been witnessing the reality of CC through increasingly intense impacts: In the devastating 2019 wildfires, in floods, heatwaves and more (Irfan, 2020). Under the oppressive predictions of CC, students across the world have been expressing their concerns. The summer of 2019 saw millions of students leaving their schools and marching in climate rallies, led by the vision of Greta Thunberg (Taylor et al., 2019). In a similar spirit, studies conducted across the globe repeatedly reveal that students are not satisfied with their CC education obtained at schools, and they want to learn more. This call for more CC education is clearly reflected in the findings of the present study - a call to action that is strongly confirmed from previous studies conducted here in Australia (Nicholls, 2017, Boon, 2014), in France (Arnould, 2013), Canada (Field et al., 2020) and the United Kingdom (Bloom, 2019).

The consistent finding regarding the inadequacy of our school graduates' CC education raises questions as to why more than a hundred years after the emergence of CC science, school curricula are still failing to address the topic properly. It is beyond the scope of this study to provide answers

to this complex question. However, some avenues for future research directions may include consideration of the following influencing factors impacting on CC education in the curriculum:

- The factors that impact on the status of CC education within the education system are of interest. The VCE structure is tightly prescribed on a traditional discipline basis, which presents a structural constraint for the curriculum design and teachers to be able to respond to the rapidly moving, cross-disciplinary topic of climate change. Perhaps also the tokenistic presence of CC in the curriculum is not accidental but rather a political decision or a symptom of decisions about maintaining an outdated educational structure designed for university entry scoring.
- It is also possible to suggest that the problem lies in the conceptualisation of CC. Most curricula subsume CC either under sustainability (Mochizuki & Bryan, 2015), or under specific subjects such as geography (Dalelo, 2012; Chang, 2015; Brownlee et al., 2012), or fragment and disperse CC across the curriculum (Boakye, 2015; Gomes & Panchoo, 2015; Nasha et al., 2018; Weart, 2012). In either approach, it becomes difficult to address CC holistically as it does not constitute a priority area.
- Another avenue to inquire into is the lack of investment in teachers' professional development in CC.

Most likely there is not one cause for the deficit found in CC education in the VCE in this study, but rather due to many contributing factors. The findings of this study form a timely reminder that students wish, in fact often demand, to learn about CC, and that by not addressing the issue adequately in our school curriculum thus far is a disservice to the students who are the citizens of the future.

In summary, this study's findings lead to a set of conclusions echoing the recommendations outlined in the paper prepared for The National Academies Board on Science Education workshop on climate change education in Formal Settings, K-12 (2011) in the United States. The report states:

> Ultimately, the ability of the elementary and secondary school systems to provide comprehensive climate literacy education will depend on the systematic availability of quality curriculum resources, impact of curriculum mandates such as state standards and assessment, and, importantly, the preparation of teachers (Simmons, 2011 p. 1).

When considering the notion of quality curriculum sources, the findings from this study indicate that these need to be much more prescriptive than the study designs currently provided by the Victorian Curriculum. Teachers require improved guidance and opportunities to interact in

communities of practice. Equally important is that CC curriculum design should be developed in consultation with CC experts, to avoid misconceptions as seen in the VCE study designs.

5.4 Implications of the study

The implications of this study are both theoretical and practical. From a theoretical perspective, the findings clearly highlight the limitations of the cross-curriculum integration of CC education. While most publications in the field of sustainability education seem to advocate this approach (UNESCO, 2018; LSF, 2020; Mochizuki & Bryan, 2015), the findings of this study and others suggest that this approach is not as effective as expected (Selby & Kagawa, 2010; Bangay & Blum, 2010). Further theoretical work is required in developing best-practices for CC education. In regard to the Victorian secondary curriculum specifically, the findings revealed deficits in the conceptualisation of CC and in the topics taught. Further research may be required in order to strengthen the theoretical basis of CC as a curricular topic. Such research may be then translated into practice and used by curriculum developers when integrating CC in the curriculum. The redesigning of curricula in regard to CC implementation, also requires that special attention be given to enhancing the hierarchical status of CC in the curricula. Studies suggest that well-designed assessments (internal and external) may be effective in ensuring the achievement of the learning outcomes and maintaining a high status for the topic within the teaching and learning process (Ross, 2000).

A further practical implication of this study includes the need to address teachers' professional development and resources availability. The findings indicated that when it comes to CC teaching, teachers are predominantly left to their own devices to identify authoritative resources and opportunities for their professional development. The curriculum itself is not prescriptive enough to provide guidance, and at the same time, no other similarly authoritative structures are available for filling the gap. It is imperative that teachers should be looked after and supported in their efforts to implement CC education (Alkaher 2020). If Education departments wish teachers to become effective teachers of CC, further funding and resources need to be directed to resources development and providing professional support to teachers. Finally, it is time that education policymakers and educators listen to the students' calls for more CC education and make concerted efforts to enhance CC education.

5.5 Limitations of the study

The study consists of two parts. The first part involves the analysis of the Victorian upper-secondary curriculum. The second part involves data collection at one school. For the analysis of the Victorian curriculum in part one, a set of key indicator criteria for identifying CC education was

developed. These criteria were derived from analysis of highly credible and internationally acclaimed publications to revealed four essential indicator terms relating to CC. Despite the indicator terms being derived from key international CC reports, it is acknowledged that other words to describe CC may appear in the curriculum.

There are many variables that impact on the curriculum pathway of the intended, to the implemented, and to the attained curricula, particularly when assessing transmission from the remembered perceptions of teachers and students as in this study. Reliance on the participants' perceptions of what CC education was taught and what CC understandings were developed is a limitation of this study, however the use of interviews as a method enabled rich data about the teachers and students' perceptions and conceptualisations; greater than if the research design used documents of lesson plans and student work.

The findings of the first part (Victorian curriculum analysis) are generalisable to upper secondary schools in Victoria. The vast majority use the same curriculum, and thus the analysis' implications for schools are the same across the state. However, this is not the case when considering the generalisability of the second part of the research. The main limitation of this study is that the data was collected from one secondary school only. Out of ten VCE study designs identified as including CC content, only seven subjects were offered at the school, and only five of the seven teachers who teach these subjects opted for participation in the research. This limits the trustworthiness of the data. It also limits the generalisability of the results beyond a single school. Different schools have different cultures and different approaches to implementing the curriculum. Approaches that may have been possible for one school do not necessarily mean that they are practised in another school. Also, the results of the study are limited to the upper-secondary for reasons explained in the methodology. However, this limits the generalisability of the findings. While the study allows to draw conclusions regarding the upper secondary, it limits the ability to draw any conclusions related to the Victorian curriculum as a whole, particularly regarding the lower years. Further studies may broaden the scope by focusing on these years

This small case study clearly sets limits on our ability to draw meanings and conclusions across Victoria and more so, across Australia. However, regardless of this limitation, it is important to note that many of the findings of this study seem to support findings found in other states of Australia and internationally (e.g. Dawson, 2015 in Western Australia; Field et al., 2020 in Canada; and Plutzer et al., 2016, in the USA). Viewed from this perspective, this small case study adds to the body of evidence accumulated internationally about the enactment of CC education in schools.

5.6 Conclusion

This study is situated at the heart of what it means to be human in the 21st century. More than anything else it requires the resilience, the know-how and the aptitude to address the myriad of challenges posed by CC - all of which require effective CC education for our young people as they grow up in a CC world. This study is foundational in the sense that it addresses the basic dimensions of CC education: The curriculum, the teaching and the learning. To the extent of knowledge, it is the first study that examines the enactment of the CC curriculum at all three levels in relation to each other. By doing so, the study was successful in gaining a deeper understanding regarding the role played by each, particularly highlighting the domino effect caused by the absence of curriculum leadership in CC education.

Additionally, the study's findings directly spotlight some critical gaps in the current CC education in Victoria's upper secondary schooling. These gaps seem pervasive across the system, beginning with a fragmented CC curriculum and ending with fragmented CC knowledge. To address these gaps, coordinated changes are required at all levels. A change in the curriculum alone will not do, nor would an isolated change in teachers' professional development. To achieve the required changes, there is a need for strong government leadership that can work together with the education sector for achieving better CC education outcomes for our emerging 21st century citizens.

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Appendices

Appendix 1a

Semi Structured Interview with Teachers

1. Questions regarding teachers views about the need to teach climate change and the role of climate change education.
    1.1. Please describe your views about climate change.
    1.2. What are your views about the role of teaching climate change to secondary school students?
    1.3. Do you think curriculum developers have placed enough emphasis on climate change education while designing the curriculum? Please explain.

2. Questions regarding teachers' views about the ways in which climate change may best be taught.
    2.1 In your opinion, what could be the best method to teach and learn climate change education particularly, to senior secondary school students?

3. Questions regarding teachers views about their confidence in teaching.
    3.1 To what extent do you feel that you that you were appropriately prepared to teach climate change?
    3.2. How do you feel about teaching this topic in the classroom?

4. Questions regarding teachers' understanding of climate change concepts.
    Climate change is a highly debated topic with different people having different understanding of what it means. I would like to ask you to share your understanding of this complex topic.
    4.1 What do you understand as the main issues concerning climate change?
    4.2 What do you perceive as the main drivers of climate change?
    4.3 What do you perceive as the main impacts of climate change?

5. Questions regarding climate change topics that are being taught.
    5.1. In what subjects that you teach, the topic of climate change is being addressed?
    5.2 Can you describe the extent to which climate change is being taught in each of the subjects that you teach?
    5.3. Please describe what you teach about climate change in each relevant subject.
    5.4. Please provide an estimate regarding the number of hours which are dedicated to climate change learning.

6. Questions regarding the integration of climate change education in and between disciplines.
    6.1 What is the approach in your school to implementing climate change. Is it being taught as a cross-curricular or is it addressed as a separate subject on its own right?
    6.2 Can you describe how this subject is integrated within the topics that you teach?

7. Questions regarding the implemented pedagogy.
    7.1 Please describe the methods you use in teaching climate change.

Thank you very much for your cooperation and time. Highly appreciated.

Appendix 1b

Semi Structured Interview Questions with Students

1. Questions regarding students' understanding of climate change concepts
    1.1. What are your views about climate change?
    1.2. How do you rate the degree of importance of climate change in our time? Please explain your answer.
    1.3. To what extent do you think you might be interested to learn about climate change?

2. Questions regarding students understanding of climate change as multisystem phenomena
    2.1. Climate change can be understood in different ways by different people. I am interested to know about your understanding of climate change.
    2.2 What do you believe are the main issues concerning climate change?
    2.3 What do you think causes climate change?

3. Questions regarding the impacts of climate change in everyday life, on societies and the world
    3.1 What do you think could be the impacts of climate change; in everyday life, on societies and the world?

4. Questions regarding the sources of information that inform students' learning of climate change.
    4.1 What are your sources of information about climate change?
    4.2 Which topics have you covered as part of climate change education?
    4.3 How many classes (periods) and which year level did you have for climate change? Do you think it was sufficient? Please explain.

Thank you very much for your cooperation and time. Highly appreciated.

Appendix 2a

Information to Participants Involved in Research – Information to Teachers

You are invited to participate

You are invited to participate in a research project entitled 'Examining the climate change education curriculum and its implementation at a Victorian secondary school'.

This project is being conducted by a student researcher, Veerendra Prasad, as part of a Master of Education program at Victoria University under the supervision of Senior Lecturers, Dr. Efrat Eilam, and Dr. Helen Widdop Quinton from the College of Arts and Education.

Project explanation

The impacts of climate change have been revealed through various studies however, efforts to combat the impacts using climate change education are still at an early stage, especially in Australia. Few studies have been carried out regarding the inclusion of climate change education in the National curriculum and it has been noted that they are inadequate for meeting the challenges. The high importance of climate change education and the scarcity of information regarding implementation in Australia in general and Victoria in particular, form the motivation for the present study.

This study will examine climate change implementation in Years 11 and 12 in one Victorian secondary school. The objectives of the study are to: examine the representation of climate change in the study designs for years 11 and 12 in the VCE curriculum; examine climate change implementation in years 11 and 12 from teachers' perspectives; and, examine climate change implementation in years 11 and 12 from the students' perspective.

What will I be asked to do?

As a participant, you will be requested to take part in an interview of approximately 40-60 minutes in duration. The interview will take place within the school's premises, at a time that will be agreed between you and the researcher, in a way that minimizes interruptions to your work. The interview will be audio recorded. You will not be asked to divulge any personal information during the interview. All the questions relate to your experience in teaching climate change at school.

What will I gain from participating?

By participating in this study, you will be contributing to extending our knowledge regarding climate change education. It is anticipated that the outcomes of this study may inform curriculum development and implementation of climate change education

How will the information I give be used?

The recorded interview will be transcribed. All the data will be coded and de-identified. Your name and identity will be known only to the research team listed below. No other person will have access to this information. All the research documents will be discarded five years after the completion of the research. The research findings will be published in a thesis report and possibly in a peer-reviewed academic journal. Any publication stemming from this research will not divulge any information that may identify you, the school, the students, other teachers, or the school community.

What are the potential risks of participating in this project?

There are no known risks involved in this study. However, if you may feel any discomfort during the interview, you may feel free opt out at any time, without any need to explain and with no consequences whatsoever. You may also request that the information you provided will be discarded and not used in the study. In case of any perceived harm, you will be referred to a

How will this project be conducted?

Prior to commencement, the researcher will meet with the teachers, explain the research and reply to any questions that may arise. Participants who express interest in the project will receive an 'information to participants' form and the 'consent' form. The researcher will schedule individual interviews with each of the participants and they will be asked to sign the 'consent' form prior to participation. The interviews will be conducted in one of the available rooms at the school. Efforts will be made to schedule interviews at times which are most convenient to the participants and minimize interruptions.

Who is conducting the study?

The study is conducted by Victoria University,
The College of Arts and Education
PO Box 14428, Melbourne, VIC, 8001

Dr. Efrat Eilam – Chief Investigator
Dr. Helen Widdop Quinton – Chief Investigator
Veerendra Prasad – Student Researcher

Any queries about your participation in this project may be directed to the Chief Investigator listed above.

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

Appendix 2b

Consent Form for Participants Involved in Research – Teachers

INFORMATION TO PARTICIPANTS:

We would like to invite you to be a part of a study into examining the ways in which Victorian Curriculum (VCE) addresses climate change and the effectiveness of climate change education implementation.

The study will contribute to curriculum development, as well as to climate change education implementation in secondary schools. The study will contribute towards developing in-depth knowledge and understanding of climate change education representation in the Victorian Curriculum (VCE) and its implementation at a school. This study will involve collecting data through semi-structured interviews. The interviews are anticipated to be 40 – 60 minutes in duration. As per the principal's discretion, the interviews will take place in either one of the available rooms, or the school library, or the staffroom. All interviews will be audio recorded and transcribed.

CERTIFICATION BY PARTICIPANT

I, _____(name) of _____(school) certify that I am at least 18 years old and that I am voluntarily giving my consent to participate in the study, "Examining climate change education curriculum and its implementation at a Victorian secondary school" being conducted at Victoria University by: Veerendra Prasad, supervised by Dr. Efrat Eilam and Dr Helen Widdop Quinton.

I certify that the objectives of the study, together with any risks and safeguards associated with the procedures listed hereunder to be carried out in the research, have been fully explained to me by: Veerendra Prasad,

and that I freely consent to participation involving the below mentioned procedures:

- Semi-structured Interview which will be approximately 40-60 minutes in duration

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this study at any time and that this withdrawal will not jeopardise me in any way.
I have been informed that the information I provide will be kept confidential.

Signed: _____

Date: _____

Any queries about your participation in this project may be directed to the researchers:

Dr. Efrat Eilam – Chief Investigator
Dr. Helen Widdop Quinton – Chief Investigator
Veerendra Prasad – Student Researcher

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email Researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

Appendix 3a

Information to Participant Involved in Research – Parents/ Guardians

INFORMATION TO PARENTS/GUARDIANS

You are invited to participate

You are invited to provide your consent to your child's/ward's participation in a research project entitled 'Examining the climate change education curriculum and its implementation at a Victorian secondary school'.

This project is being conducted by a student researcher, Veerendra Prasad, as part of a Master of Education course at Victoria University, under the supervision of Dr. Efrat Eilam and Dr Helen Widdop Quinton, from the College of Arts and Education.

Project explanation

The impact of climate change has been revealed through various studies however, efforts to combat the impacts using climate change education are still at an early stage, especially in Australia. Few studies have been carried out regarding the inclusion of climate change education in the National curriculum and it has been noted that they are inadequate for meeting the challenges. The high importance of climate change education and the scarcity of information regarding implementation in Australia in general and Victoria in particular, form the motivation for the present study.
This study will examine climate change implementation in Years 11 and 12 in one Victorian secondary school. The objectives of the study are to: examine the representation of climate change in the study designs for years 11 and 12 in the VCE curriculum; examine climate change implementation in years 11 and 12 from teachers' perspectives; and, examine climate change implementation in years 11 and 12 from the students' perspective

What will participants be asked to do?

Your child will be requested to take part in an interview of approximately 40 - 60 minutes in duration. The interview will take place within the school's premises, at a time that will be agreed between the researcher and the participant. The interviews will be audio recorded. Your child will not be asked to divulge any personal information during the interview.

What will the participants gain from participating?

By participating in this study, your child/ward will be contributing to extending our knowledge regarding climate change education and the ways in which this subject may be implemented effectively at schools.

How will the information given by the participants be used?

The recorded interviews will be transcribed. All the data will be coded and de-identified. The name and identity of the participants will be known only to the researcher, Veerendra Prasad. No other person will have access to this information. All the research documents will be discarded five years after the completion of the research. The research findings will be published in a thesis report and possibly in a peer-reviewed academic journal. Any publication stemming from this research will not divulge any information that may identify the school, the students, the teachers, or the school community.

What are the potential risks of participating in this project?

There are no known risks involved in this study. However, students who may feel discomfort during the interview may opt out at any time, without any need to explain and with no consequences whatsoever. They may also ask for the information provided by them, to be discarded and not used in the study. In case of any perceived harm, the participants will be referred to a suitable psychological support.

How will this project be conducted?

Prior to commencement, the researcher will meet with the students, explain the research and reply to any questions that may arise. Participants who express interest in the project will receive an 'information to participants' form and an 'assent' form. All interested participants will be asked to obtain their parents'/guardians' consent for participation and sign an 'assent' form prior to participation. The researcher will schedule time for individual interviews with each participant. The interviews will be conducted in one of the available rooms at schools. Efforts will be made to schedule interviews at times which are most convenient to the participants and minimize interruptions.

Who is conducting the study?

The study is conducted by Victoria University,
The College of Arts and Education
PO Box 14428, Melbourne, VIC, 8001

Dr. Efrat Eilam – Chief Investigator
Dr. Helen Widdop Quinton – Chief Investigator
Veerendra Prasad – Student Researcher

Any queries about your participation in this project may be directed to the Chief Investigator listed above.

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

Appendix 3b

Information to Participants Involved in Research - Students

INFORMATION TO STUDENTS

You are invited to participate

You are invited to participate in a research project entitled 'Examining the climate change education curriculum and its implementation at a Victorian secondary school'.

This project is being conducted by a student researcher, Veerendra Prasad, as part of a Master of Education course at Victoria University, under the supervision of Dr. Efrat Eilam and Dr. Helen Widdop Quinton, from the College of Arts and Education.

Project explanation

The impacts of climate change have been revealed through various studies however, efforts to combat the impacts using climate change education are still at an early stage, especially in Australia. Few studies have been carried out regarding the inclusion of climate change education in the National curriculum and it has been noted that they are inadequate for meeting the challenges. The high importance of climate change education and the scarcity of information regarding implementation in Australia in general and Victoria in particular, form the motivation for the present study.

This study will examine climate change implementation in Years 11 and 12 in one Victorian secondary school. The objectives of the study are to: examine the representation of climate change in the study designs for years 11 and 12 in the VCE curriculum; examine climate change implementation in years 11 and 12 from teachers' perspectives; and, examine climate change implementation in years 11 and 12 from the students' perspective.

What will I be asked to do?

As a participant, you will be requested to take part in an interview of approximately 40-60 minutes in duration. The interview will take place within the school's premises, at a time that will be agreed between you and the researcher, in a way that minimizes interruptions to your school-work. The interview will be audio recorded. You will not be asked to divulge any personal information during the interview. All the questions relate to your experience in studying climate change at school.

What will I gain from participating?

By participating in this study, you will be contributing to extending our knowledge regarding climate change education and the ways in which this subject may be taught effectively at schools.

How will the information I give be used?

The recorded interview will be transcribed. All the data will be coded and de-identified. Your name and identity will be known only to the research team, listed below. No other person will have access to this information. All the research documents will be discarded five years after the completion of the research. The research findings will be published in a thesis report and possibly in an academic journal. Any publication stemming from this research will not divulge any information that may identify you, the school, other students, the teachers, or the school community.

What are the potential risks of participating in this project?

There are no known risks involved in this study. However, if you may feel any discomfort during the interview, you may feel free to opt out at any time, without any need to explain and with no consequences whatsoever. You may also request that the information you provided will be discarded and not used in the study. In case of any perceived harm, you will be referred to a suitable psychological support.

How will this project be conducted?

Prior to commencement, the researcher will meet with the students, explain the research and reply to any questions that may arise. Participants who express interest in the project will receive an 'information to participants' form and an 'assent' form. All interested participants will be asked to obtain their parents'/guardians' consent for participation and sign an 'assent' form prior to participation. The researcher will schedule time for individual interviews with each participant. The interviews will be conducted in one of the available rooms at schools. Efforts will be made to schedule interviews at times which are most convenient to the participants and minimize interruptions.

Who is conducting the study?

The study is conducted by Victoria University,
The College of Arts and Education
PO Box 14428, Melbourne, VIC, 8001

Dr. Efrat Eilam – Chief Investigator
Dr. Helen Widdop Quinton – Chief Investigator
Veerendra Prasad – Student Researcher

Any queries about your participation in this project may be directed to the Chief Investigator listed above.

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

Appendix 4

Consent Form for Participants Involved in Research – Parents/ Guardians

INFORMATION TO PARTICIPANTS:

We would like to invite your child/ward to be a part of a study into examining the ways in which Victorian Curriculum (VCE) addresses climate change and the effectiveness of climate change education implementation.

The study will contribute to curriculum development, as well as to climate change education implementation in secondary schools. This study will involve collecting data through semi-structured interviews with teachers and their students. Each interview is anticipated to be 40 – 60 minutes in duration. As per the principal's discretion, the interviews will take place in either one of the available rooms, or the school library, or the staffroom. All interviews will be audio recorded and transcribed.

CERTIFICATION BY PARTICIPANT'S PARENT/ GUARDIAN

I, _____ Parent/ Guardian
of_____ (Participants name) of_____
_____(school) certify that I am at least 18 years old and that I am voluntarily giving my consent for _____(Participants name) to participate in the study, "Examining climate change education curriculum and its implementation at a Victorian secondary school" being conducted at Victoria University by: Veerendra Prasad, supervised by Dr. Efrat Eilam and Dr Helen Widdop Quinton.
I certify that the objectives of the study, together with any risks and safeguards associated with the procedures listed hereunder to be carried out in the research, have been fully explained to me and to my child/ ward by: Veerendra Prasad,

and that I freely give consent to my child/ ward to participation involving the below mentioned procedures:

- Semi-structured Interview which will be approximately 40-60 minutes in duration

I certify that my child/ ward has had the opportunity to have any questions answered and that I understand that my child/ ward can withdraw from this study at any time and that this withdrawal will not jeopardise my child/ ward in any way.

I have been informed that the information that my child/ ward provide will be kept confidential.

Signed: _____
Date: _____
Any queries about your participation in this project may be directed to the researchers:

Veerendra Prasad
Dr. Efrat Eilam
Dr. Helen Widdop Quinton

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email Researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

Appendix 5

Assent Form for Participants Involved in Research

Student of _____(School)

Project: Examining climate change education curriculum and its implementation at a Victorian secondary school

Chief Investigator: Dr. Efrat Eilam

Dr. Helen Widdop Quinton

Student Researcher: Mr. Veerendra Prasad

I have been asked to take part in the Victoria University research project specified above. I have read and understood the Information to Participation Statement and I hereby assent to participate in this project.

I consent to the following:	Yes	No
The data that I provide during this research may be used for the purpose of the project listed above	☐	☐
Audio recording during the interview.	☐	☐

Name of Participant _____

Participant Signature _____ Date_____