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Understanding how Queensland teachers' views on climate change and climate change education shape their reported practices.

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ABSTRACT

Climate change presents significant challenges to current and future generations. Students must be prepared to face these challenges however climate change education presents many challenges to educators. First, climate science is complex, scientific understandings continue to develop and refine over time with the potential consequences, and implications of a changing climate still quite uncertain. Second, climate change education not only deals with science but is intertwined with many additional complex social, environmental, political, and economic issues which do not fit neatly into school subjects. The Australian Curriculum, including the Cross Curriculum Priority of Sustainability, may provide space for teachers to engage with the complexities of climate change (Australian Curriculum Assessment and Reporting Authority (ACARA), 2015a, 2015b) but does not encourage teachers to engage with climate change as a complex, multi-dimensional issue.

When considering the implementation of climate change education the role and perspectives of classroom teachers needs to be examined. Teachers approach curriculum with diverse experiences, ideas, beliefs, and values that shape the way they interpret and respond to curriculum documents (Cotton, 2006; Nespor, 1987; Pajares, 1992). In the context of changing national and state curriculum frameworks and policies concerning education for sustainability (EfS), it is especially important to examine the role and influence of teachers' beliefs about climate change and pedagogy on the climate change education practices within their school classrooms. The purpose of this doctoral research study was to explore teachers' understandings of climate change and climate change education and how these understandings, along with other factors identified by teachers, influence their engagement with and approach to climate change education.

An explanatory sequential (quan -> QUAL) mixed methods research design was used to examine teachers' perceptions of: 1) Climate change, including the credibility of climate change science, the causes of climate change and the likelihood and severity of consequences; and 2) Climate change education, including beliefs relating to the necessity or appropriateness of climate change as

an educational focus, and how these beliefs influence teachers' curriculum planning and decisions regarding the issue/topic of climate change. Phase one collected survey data from over 300 Queensland primary and secondary teachers which were analysed to identify their understandings and beliefs relating to the realities, causes, and consequences of climate change and to illuminate how they conceptualise climate change education in terms of pedagogical content and processes. Phase two collected in-depth qualitative data through semi-structured interviews with 21 teachers from across Queensland. Interview data were analysed thematically and built upon data collected in phase one to present a more nuanced understanding of teachers' perceptions.

This research found many teachers accept that the climate is changing, but hold various views on the causes of climate change. Regardless of their position on climate change, teachers in this study indicated that climate change was an educational priority for them. However, it appears that these teachers do not directly engage with climate change as a complex multi-dimensional issue or associate climate change learning with action, resilience and adaptive capacity, either individually or within local community contexts. Climate change education, in most cases, is understood to be (climate) science education focused on students developing an opinion on causes. Teachers feel strongly about their role as impartial information providers and many believed climate change 'science' education should be taught using a balanced approach (i.e. providing 'both' sides of the climate change science) and allowing students to make up their own minds. The teachers within this study do not feel supported by their curriculum documents to include climate change and as such many do not include the issue in a formal capacity, but rather rely on incidental conversations and discussions. Teachers that do include climate change within their lessons, source information on the issue through personal investigation and self-learning. These findings suggest that Queensland's formal schooling sector's capacity for preparing Queensland students to be informed, decision making citizens on climate change must be questioned and highlight the implications for curriculum, resources and teacher professional development.

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We all have an impact on the environment, economy and people of Queensland. Through systems thinking and behaviour change, our environment can be sustained for the communities of the future. It is imperative that our schools, education systems and our communities play a role now to invest in that future.

The Queensland Government's

'Statement on Sustainability for All Queensland Schools –

enough for all forever' (DETA, 2007).

1.0 Climate change

The earth's climate is changing. The last three decades have been warmer than any preceding decade since 1950, with the period of 1983 to 2012 likely to have been the warmest 30 year period in the northern hemisphere over the last 1400 years (Intergovernmental Panel on Climate Change (IPCC), 2014). The primary cause of observed changes in Earth's climate over the recent past, as well as predicted future changes, are anthropogenic greenhouse gas (GHG) emissions, namely carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), produced since the beginning of the industrial era (IPCC, 2014). It is almost certain current GHG levels have resulted in an increase in extreme weather across the globe, including heatwaves and extreme rain events (Commonwealth Scientific and Industrial Research Organisation (CSIRO) & Australian Bureau of Meteorology (BOM), 2014; IPCC, 2014).

The impacts of climate related extremes are affecting natural systems including terrestrial and marine ecosystems, with scientists confident climate change has increased tree mortality rates in certain regions, intensified glacial melting, increased sea levels, altered animal migration patterns and shifted the geographic ranges of some species (IPCC, 2014). Further, observed impacts on a number of human systems in some regions include food and water supply disruptions, damage to infrastructure and settlements, increases in human morbidity and mortality, and negative effects for human wellbeing and mental health (CSIRO & BOM, 2014; IPCC, 2014).

The future implications of a warming climate are also bleak. It is predicted a future with climate change will include more frequent and prolonged heatwaves and a disruption to rain events including increased precipitation in some regions and a decrease in others (CSIRO & BOM, 2014). The IPCC Assessment Report Five (AR5) (2014) anticipates warming to result in a number of serious scenarios. Oceans will become increasingly acidic and marine creatures will battle decreased oxygen levels and increased water temperatures. Additionally, large proportions of plant and animal species face increased risk of extinction, especially when the effects of climate change interact with other pre-existing stressors. Likewise, climate change is also predicted to increasingly impact human systems, for example, it is anticipated climate change will undermine food security, and intensify risks for already disadvantaged people and communities (CSIRO & BOM, 2015; IPCC, 2014).

Under all emission scenarios warming is anticipated to continue for centuries. Even with a complete end to GHG emissions global average temperatures will remain elevated, oceans will continue to acidify and warm, and global communities will face increased vulnerability (IPCC, 2014). To reduce the risk of abrupt, irreversible changes, mitigative action is necessary. Scientists warn without mitigation efforts that go beyond current global attempts to reduce emissions severe, widespread and irreversible global impacts can be expected (IPCC, 2014). Alongside mitigation, adaptation is also viewed as increasingly necessary for reducing and managing the risks posed by climate change. Adaptation will necessarily be place and context specific, with local governments and communities vital to the process.

In the face of this challenge education arguably has the potential to play a vital role (Kagawa & Selby, 2010). Article 6 of the United Nations Framework Convention on Climate Change (UNFCCC) urges all countries to promote and facilitate education and public awareness of climate change (United Nations, 1992). However, climate change education presents many challenges to educators (Stevenson et al, 2011; Moser, 2010). Climate science is complex and scientific understandings continue to develop and refine over time. Adding to this complexity are the uncertainties surrounding the potential consequences, implications, timing and scale of a changing climate. Further, climate change education does not only deal with science but is intertwined with many additional complex social, environmental, political, and economic issues including economic development and poverty reduction (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2010). Alongside these complexities it appears little attention has been paid within formal education to the consequences of climate change, or the need for adaptation to its impact on human settlement and activities (Kagawa & Selby, 2010).

1.1 Research problem and objectives

Climate change presents many scientific and sociological challenges to current and future generations. Although the impacts of climate change are uncertain, scientists agree the implications will be largely negative. The continued 'business as usual' approach to human activities will lead to further warming and lasting changes to Earth's climate. The IPCC reports further argue that limiting the negative implications of climate change will require a substantial reduction in greenhouse gases, along with adaptation efforts to minimise vulnerability and limit risk due to the long lasting nature of greenhouse gases already in the atmosphere and their locked in effects.

Climate change mitigation and adaptation will require policy makers, individuals and communities who are knowledgeable and who hold the relevant skills, values and dispositions to enable informed decision making and appropriate actions. Today's school students will be tomorrow's decision makers and community leaders (Mower, 2012; Shepardson, Niyogi, Roychoudhury, & Hirsch, 2011). If current and future generations are to be empowered and effective in facing these challenges they must be prepared with the appropriate knowledges, skills and dispositions required. As such, education is a critical component of successful climate change mitigation and adaptation, its integral role supporting learners to build the capacity to effectively minimise human contributions and to "adapt individual lives and livelihoods as well as ecological, social or economic systems in a changing environment" (Anderson, 2010, p. 6).

When considering the implementation of climate change education the role of classroom teachers needs to be addressed. The understandings, beliefs, attitudes, motivations and skills of the classroom teacher (UNESCO, 2010) contribute significantly to the kind of curriculum practices that are enacted. The purpose of this doctoral research study was to explore Queensland teachers' understandings of climate change and climate change education and how these understandings along with other factors identified by teachers, influence their engagement with climate change education.

This research is underscored by the central premise that scientists working within the various fields associated with climate change science are confident the climate is changing, human influences are the major cause of climate change and that climate change education is necessary for human health and well-being as well as the well-being of the planet.

1.2 Research questions

This research project was framed by an overarching or central research question and guided by seven sub-questions; three specifically related to teachers' personal beliefs about climate change and four questions to guide the research relating to teachers' professional beliefs about climate change education.

Overarching research question:

How do teachers' understandings of climate change and beliefs about climate change education influence their teaching of climate change?

Sub questions:

Climate Change

1. How do teachers understand climate change?
2. What are the sources of information teachers use to inform themselves about climate change?
3. What are the personal beliefs of teachers about the causes and consequences of climate change?

Climate Change Education

4. What does climate change education mean to teachers?
5. What are the beliefs of teachers about the need for and appropriateness of climate change education?
6. What do teachers report as influencing their decision to include or exclude climate change in their curriculum?
7. What do teachers report as their classroom practice in relation to climate change?

1.3 Overview of methodology

The purpose of this research was to examine and begin to develop an **insight into Queensland teachers':** 1) **understandings** of **climate change**, including the validity of climate change science, as well as, perspectives on the causes of climate change and likelihood and severity of consequences and influences on these perceptions and 2) **beliefs** about **climate change education**, including beliefs relating to the necessity or appropriateness of climate change as an educational focus, and how these beliefs influence teacher curriculum planning and decisions. With these goals as a guide, an explanatory sequential (quan → qual) mixed methods research design (Creswell, 2012; Creswell & Plano Clark, 2011) was employed.

Research was undertaken over two phases, phase one of the study employed an online survey to collect data from Queensland teachers currently registered with the Queensland College of Teachers. The survey consisted of 28 questions including eight demographic questions, 10 questions relating to personal beliefs and understandings about climate change and eight questions relating to professional understandings about climate change education including their reported practices. Phase two consisted of one on one semi-structured interviews with twenty one teachers identified through the initial survey.

1.4 Research context

Curricula, or schooling more generally, in Australia has historically been the responsibility of individual states and territories, however a federal agenda strengthened by the 2007 election of the Rudd Labor government and concerns over Australian school student performance in international testing, has seen an increased federal presence (Lingard, 2010). This federal presence is manifested through increased testing and accountability, most evidently through the establishment of a new federal body, the Australian Curriculum and Reporting Authority (ACARA), the implementation of the National Assessment Program – Literacy and Numeracy (NAPLAN), and the creation of the 'My School' website (Lingard, 2010), the latter of which presents public data from national testing and claims to "provide information about schools in Australia, letting you see how a school is performing, compared to schools with similar students" (ACARA, 2016a, para 1). NAPLAN testing takes place annually in years 3, 5, 7 and 9 in all schools throughout Australia and consists of tests slated to assess student progress in reading, writing, language conventions and numeracy (ACARA, 2016b).

The apparent poor performance of Queensland students in the inaugural NAPLAN testing in 2008 prompted an inquiry into Queensland schooling practices known as the Masters Report (Hardy, 2015; Masters, 2009). The report recommended increased time spent on test readiness, including the use of previous NAPLAN tests by schools, to increase student test taking experiences and improve test taking skills (Masters, 2009; Hardy, 2015). As a result of the Queensland government's agenda to increase test scores, 'Teaching and Learning Audits' have also been introduced across all Queensland State schools, where each school is ranked against eight elements intended to provide feedback on school performance (Lingard, 2013). Queensland government schools are expected to continue to improve their NAPLAN tests results relative to the mean and schools must develop plans to ensure students are meeting the minimum national standards in literacy and numeracy (Department of Education and Training, 2012; Carter, 2016). These measures appear to have resulted in some successes. Queensland schools have shown an increase in their overall performance, with the Queensland Premier congratulating Queensland schools in 2015 for demonstrating the "greatest improvement of any state or territory" since NAPLAN's commencement in 2008 (Palaszczuk, 2015, para 3). However, recent research also suggests Queensland schooling has been negatively influenced by the increased accountability and pressure for improved NAPLAN results (Hardy, 2015; Lingard, 2013). These foci, it has been argued, have resulted in "perverse flow-on effects such as goal displacement, teaching to the test and the naturalization of data as the most sensible medium for thinking about teaching and learning" (Lingard, 2013, p. 652). Teachers and principals are claimed to be particularly influenced by the performative demands of state and federal policy (Hardy, 2015; Carter, 2016) leading to the prioritising of test scores over other educational aims.

The federal presence in schooling can also be seen in the recent introduction of the Australian Curriculum in all Australian states and territories commencing in 2012. Queensland is currently in Phase 3 of the Australian Curriculum rollout, after the implementation of English, Mathematics, Science, History and Geography curriculum areas over previous phases, Phase 3 sees the endorsement of Civics and Citizenship, Economics and Business, Health and Physical Education, Languages, Technologies and the Arts (Queensland Government, 2016). The Queensland state educational authority, Education Queensland, responded to the Australian Curriculum by developing 'Curriculum into the Classroom' (C2C), a comprehensive set of unit and lesson plans, assessment instruments and resources designed to assist Queensland teachers with the implementation of the new curriculum (The State of Queensland (Department of Education and Training), 2015). Although C2C documents were developed as a teaching guide, research suggests some teachers and school regions have felt pressure to enact the curriculum by closely following lesson plans as written with the result being a reduction of teacher autonomy, as well as that of school principals and school-based practices more broadly (Hardy, 2015; Barton, 2014).

In summary, the current educational context in Australia and regionally in the state of Queensland, is one moulded by neoliberal principles including the marketisation of education based on competition and 'consumer' choice (Klenowski, 2011). In Queensland the effects of auditing and accountability have been particularly prominent. The Queensland Department of Education and Training embraced performance assessments centred on yearly NAPLAN data sets (Gable, 2015). This model, according to some observers, has resulted in negative educational consequences such "bolt-on test preparation and narrowed educational objectives" (Carter, 2016, p. 339). Teaching to the test and a narrowed prescribed curriculum has arguably weakened teachers' capacity for autonomous judgement and developing curricula that is locally relevant or appropriate for their students (Connell, 2013). However, it has also been argued that in the face of reduced autonomy teachers may maintain a resistance to the reductive effects of overt state and federal policy pressures through their engagement and implementation of curriculum (Barton, 2014).

1.5 Climate change and the Australian Curriculum

Climate change is not a standalone topic within the Australian Curriculum nor is there any prolonged or sequenced engagement with the topic. Most frequently climate change appears as a suggested 'elaboration' rather than as core content that must be included. When climate change is included in the curriculum, the language used is often tentative and uncertain (Whitehouse, 2013), and often does not provide guidance on how climate change may be approached in terms of the position the curriculum takes on climate change science and anthropogenic influences on climate change, leaving the issue open for wide and varied interpretation. A more comprehensive picture of the Australian Curriculum can be found in chapter three.

1.6 Conceptual framework

The conceptual parameters that framed this study were informed by the overarching research question which essentially is concerned with teachers' understandings of climate change, teachers' beliefs about climate change education, and how these may intersect and influence the teaching of climate change education in Queensland schools. This study moves beyond the knowledge dimension of climate change understanding in recognising that it is more than teacher knowledge alone that influences teacher practices (Pajares, 1992; Fives, 2012). Conceptualising teacher beliefs as a teacher's worldview, or all that a teacher presupposes about the world, this research contends that teacher beliefs act as filters for interpretation, frames for defining problems and/or guides or standards for teacher practice (Fives, 2012). As such teacher educational beliefs must be considered in terms of their connections with other beliefs, such as political and religious beliefs, as they exist as integrated complex systems. Given that teachers' understandings of climate change were a key focus of the study, a way of conceptualising such understandings was determined as desirable for framing this part of the investigation. 'Understanding climate change' has been identified from reviewing the literature to include six dimensions, these are: awareness, knowledge, beliefs, risk perceptions, responses, and engagement. Although these dimensions are not readily separated in reality, they serve as a useful framework for investigating the diverse influences on individuals' understandings of climate change. In the case of climate change education teachers beliefs and reported practices were investigated considering climate change education as a holistic engagement with climate (climate change science) and change (implications for Earth systems including human life, health and wellbeing) (McKeown & Hopkins, 2010). These ideas will be examined further in chapter two.

1.7 Outline of chapters

The remainder of this thesis is organised into seven chapters. Chapter two provides a review of pertinent literature, including an engagement with literature exploring how individuals understand climate change, a review of the influence of teacher beliefs on teacher practice and an overview of climate change education literature. Next, chapter three outlines the research methodology and describes the research methods. Chapters four and five present the findings of this study. Chapter four reports findings related to the first set of sub-research questions focused on climate change. Chapter five reports findings related to the second set of sub-research questions focused on climate change education. Chapter six engages analytically and critically with the findings outlined in chapters four and five and discusses these in reference to the overarching research question guiding this study. Finally chapter seven will provide an overview of the research findings, discuss the implications of this research, and provide specific recommendations for policy, practice and future research.

Chapter Two
Literature Review

2.0 Introduction

Orr (1992) argues students need to know and learn about our connection with the earth and how all other things revolve around this relationship. However, studies have shown many current and pre-service teachers may understand little about their relationship to the natural environment and the earth (Boon, 2010; Cutter-Mackenzie & Smith, 2003; Green & Summerville, 2015; Papadimitriou, 2004). Currently, many of the teachers who will be asked to teach climate change education will have no formal education that has explicitly dealt with the socio-scientific issues they will be expected to explore with their students (Cutter-Mackenzie & Smith, 2003; Wise, 2010).

This research seeks to gain an insight into teachers' understandings of climate change and their beliefs about climate change education and how these influence the teaching of climate change in Queensland schools. In order to situate this research within existing literature and provide conceptual parameters from within which to explore the research questions, this literature review will be organised under three themes central to the guiding research question: How do teachers' (1) understandings about climate change and (2) beliefs about climate change education (3) influence their teaching of climate change? The review will begin by drawing on literature that explores the ways in which individuals understand climate change (1). I identify six dimensions of understanding climate change in an attempt to illuminate the complexity of people's understandings of the issue before examining the limited literature on teachers' understandings of climate change. Next, I examine teacher beliefs and their influence on teaching practice including the teaching of controversial issues (2). Finally, the emerging educational responses to climate change are examined by drawing on literature and the insights of researchers and theorists working in the critically important, broadly defined field of climate change education (3).

2.1 Understanding climate change

Understanding is a clear goal of many educational initiatives focused on climate change. How people understand climate change and the reasons for these understandings have been the focus of increasingly prolific research. The Oxford dictionary ("Understand," n.d.) defines understand as: 1. Perceive the intended meaning of (words, a language, or a speaker), 2. Interpret or view (something) in a particular way, or 3. Be sympathetically or knowledgeably aware of the character or nature of. The phrase 'understanding climate change' within research literature has been used in a variety of ways, with researchers identifying and investigating several conceptions of what it means to understand climate change. Notwithstanding the richness of literature exploring individual's understandings of climate change, research examining the climate change understandings of teachers is limited. As such, this review begins by examining understandings of climate change within the wider public under the assumption that teachers' understandings of climate change will be similar. The below review outlines the conceptual framework and foundation from which teachers' understandings of climate change are explored. Through examining the literature researching individuals' understandings of climate change it became apparent that researchers investigating 'understanding' climate change incorporated broadly defined and conceptualised definitions of the term. Upon review six key themes within the 'understanding climate change' literature were identified, awareness; knowledge; beliefs; risk perceptions; responses and engagement. As such, the following review examines understanding of climate change, not in its more narrow common form typically assumed to mean knowledge, but rather under these themes in an attempt to explore the multiple ways an individual may understand the issue. Following, research investigating teachers' understandings of climate change will be considered.

2.1.1 Awareness

Various researchers have used the term 'understand[ing] climate change' when investigating individual and group awareness of climate change. Raising awareness is often lauded as a key aim of climate change information or education programs. Article 6 of the UNFCCC for example, urges all countries to promote and facilitate education and public awareness of climate change (United Nations, 1992). Leiserowitz (2008) identified awareness as having "heard of" or being familiar with the term global warming or climate change. Widespread awareness of climate change is seen as an important factor in minimising long term vulnerability. A lack of awareness is argued as limiting action to mitigate and adapt to climate change, including individual and community development, agricultural, and water management planning (Leiserowitz, 2008).

Climate change awareness is high in most developed countries, however in some regions of the world awareness is low or non-existent (see for example: Pelham, 2009; Pew Research Center, 2006). Gallup Polls conducted in 2007-2008 across 127 countries found more than a third of the world's population had never heard of climate change (Pelham, 2009). Never having heard of the term 'climate change' does not necessarily indicate individuals are unfamiliar with changes to their local climate. People may have "observed, attempted to explain … [or] adapt to changes in their local climate" (Leiserowitz, 2008, p. 8) but not have the exposure to climate change science, and the language and theories this would provide. Importantly, awareness in terms of understanding climate change does not include having experiences with climate change if the individual is unaware that those experiences are related to climate change and that there is a collective scientific knowledge being amassed on the issue. Awareness of climate change in some cases also refers to an individual holding some insight into the causes and consequences of climate change which may or may not include a general awareness that there are ways to mitigate and/or adapt to the effects of climate change.

Within the Australian context many are familiar with the concept of climate change (Pugliese & Ray, 2009; Reser, Bradley, Glendon, Ellul, & Callaghan, 2012). However, many Australians are unfamiliar with terminology relating to climate change, for example 81.4% and 73.3% of respondents to a 2013 survey of the Australian public were unfamiliar with the terms climate change mitigation and climate change adaptation respectively (Leviston, Price, Malkin, & McCrea, 2014).

2.1.2 Knowledge

Weber and Stern define understanding climate change as:

> a set of cognitions about what 'climate' and 'climate change' mean, what the essential attributes of climate are, how these attributes are connected to each other, what causes climate change, what the consequences of climate change will be, and the degree of confidence that should be placed in various knowledge claims about climate change (2011, p. 315).

Numerous scholars also define understanding climate change in terms of knowledge, including; acquiring and employing factually correct knowledge of climate change (Wolf & Moser, 2011), for example, knowledge of the physical processes (Bulkeley, 2000) or the mechanisms for climate and how they are connected (Weber & Stern, 2011); knowledge of the causes and consequences of climate change (Kempton, 1991; Stamm, Clark, & Eblacas, 2000; Weber & Stern, 2011; Whitmarsh, 2009); and potential mitigative or adaptive strategies that may be employed (Papadimitriou, 2004; Stamm et al., 2000).

Amongst the general public there is widespread public uncertainty regarding the science of climate change, as well as, a general confusion between climate change and other environmental concerns. Most common is the confusion between climate change and the ozone hole and weather vs. climate (Bostrom, Morgan, Fischhoff, & Read, 1994; Leiserowitz, Smith, & Marlon, 2010; Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007). In a national study within the US, Leiserowitz et al. (2010) found large majorities of those studied incorrectly attribute the hole in the ozone layer and spray cans to global warming. Further, participants in this study were aware of a difference between climate and weather, however, many held incorrect understandings about each which lead researchers to suggest confusion between the two terms. Similarly, Lorenzoni et al. (2007) found participants often discussed ozone depletion when discussing climate change and others offered recycling as a solution. Bostrom et al. (1994) found individuals held several misconceptions regarding climate change. First, nearly all participants who gave a “mechanistic account” of climate change included an account of increased ultraviolet light caused by a hole in the ozone layer (Bostrom et al., 1994). Second, in addition to merging various environmental concerns into one, misconceptions of the relative importance of factors affecting climate change were also found, including the exaggerated importance of deforestation compared with other factors (Bostrom et al., 1994).

An individual’s ignorance of complex systems such as the climate system have been argued as one possible reason for wait and see approaches to mitigation and adaptation. Sterman and Booth Sweeney (2007) have undertaken a series of studies examining understandings of climate change. They argue many people view the climate as a linear system with short time lags between corrective action (reducing CO_2 emissions) and positive results (climate stability and overall reduction in global temperatures), rather than a dynamic system with multiple positive feedbacks and long delays. They hypothesised that the "widespread underestimation of climate inertia arises from a more fundamental limitation of people's mental models: weak intuitive understanding of stocks and flows – the concept of accumulation in general, including principles of mass and energy balance" (2007, p.215). In an earlier study Sterman and Booth Sweeney (2002) found many people used a pattern-matching heuristic to project future climate in which system inputs and outputs are assumed to be correlated. They noted however that "[t]he stock/flow structure means climate dynamics are fundamentally incompatible with such naive 'common sense' approaches" (2002, p.232). Sterman and Booth Sweeney (2007) propose flawed mental models may account for some of the contradiction between public calls to limit climate change and the wait and see philosophy held by many. Rather than individuals being self-serving and short sighted, "people may simply, but erroneously, believe that stabilizing emissions quickly stabilizes the climate" (Sterman & Booth Sweeney, 2007, p.234). Further, Bostrom et al. (1994) contend these flawed mental models restricted the ability of individuals to distinguish between effective and ineffective strategies of mitigating climate change.

Chen (2011) argued further that, in addition to a limited mental model, the extensive misconstruction of climate change and the persistence of pattern matching heuristics, even after the acquisition of basic knowledge of dynamic systems, arises from an error in people's ontological assumptions. Chen states when people adopt a pattern matching heuristic they have treated the climate system as an object rather than a dynamic process. Chen (2011, p.6) argues that to understand climate change we need to see it as a process, "a distinct kind of ontological entity with fundamental differences from objects". However due to our "inherent preference for objects" and "well-entrenched core system of object knowledge" (Chen, 2011, p. 13) it is easier to adopt pattern matching heuristics than comprehend important climate features including temporal totality and inertia.

Knowledge is frequently viewed as an important component of how the public understands climate change (Reser et al., 2012), particularly in terms of acceptance of anthropogenic climate change. This assumption has been challenged more recently with some research suggesting that those with higher scientific literacy skills may be more likely to be sceptical of climate change science and the consensus on anthropogenic influences (Kahan et al., 2012).

Within the Australian context, Australians appear confident in their personal knowledge about climate change, indicating they feel they know something, and in many cases a great deal, about the issue (Pugliese & Ray, 2009; Reser et al., 2012). However in reality Australians appear to hold only modest levels of climate change science knowledge (Reser et al., 2012). A number of studies have shown Australians hold high levels of uncertainty when it comes to climate change science (Ashworth, Jeanneret, Gardner, & Shaw, 2011; Bulkeley, 2000; Reser et al., 2012). A large number of Australians believe the hole in the ozone layer is contributing to global warming or select unsure/don't know for example (Ashworth et al., 2011; Reser et al., 2012).

2.1.3 Beliefs

Together with the notion of knowledge about climate change, researchers also use the term understandings when discussing individual's beliefs relating to the occurrence of climate change, the validity of climate change science; including availability and reliability of evidence, and attribution of cause i.e. anthropogenic, natural or a combination of the two (Leiserowitz, 2008; Papadimitriou, 2004; Whitmarsh, 2009; Wolf & Moser, 2011). The term belief is used by many contemporary philosophers to refer to the attitude we have whenever we take something to be the case or regard it to be true (believe) (Schwitzgebel, 2010), or untrue (disbelieve) (Lemos, 2007). Beliefs can range in "intensity or strength from complete and firm conviction to tentative and cautious acceptance" (Lemos, 2007). Further, beliefs guide our actions and are highly resistant to change (Frijda, Manstead, & Bem, 2000).

Frequently studies are conducted using polls or surveys with large groups or specific sub groups of the public, for example teachers or university students, to gauge beliefs relating to changes in the climate and human influence on any change that has occurred (see for example, Boon, 2010; Papadimitriou, 2004). A survey of 3,096 Australians in 2010 for example, found 74% of respondents believed the world's climate is changing and 90% believed human activities played a causal role (Reser et. al., 2012).

However despite the apparent agreement, climate change science remains controversial within the general public. Many reasons have been put forward as promoting widespread doubt about the validity of climate science claims. Included in these is the proliferation of anti-science propaganda by individuals and businesses that fear loss of revenue if measures are taken to reduce CO_2 emissions. It has been argued individual and business greed and concerns for economic growth have been a driving force behind 'anti-climate campaigns'. Hamilton (2010, p.35) for example, argues that the "principal obstacle to coming to grips with global warming" is affluent society's fetish with economic growth. Hamilton (2010) describes the "growth fetish" as a religious value invested in growth of the economy and the accumulation of individual wealth and argues that growth is seen as the answer to many issues facing humanity. Describing political leaders as regarding growth as having magical powers that can provide the solution, a cure all, to all social problems: economic growth will save the poor, solve unemployment, provide better schools and hospitals, and increased economic growth will generate the means to fix environmental problems. As economic growth is a symbol of national pride, consumerism is seen as an individual's means of assessing self-worth and developing a sense of identity (Hamilton, 2010).

Researchers studying the motives surrounding individuals' continued distrust in climate science propose various reasons why doubt and confusion surrounding this science continue despite increasing confidence amongst scientists. These theories include low scientific literacy as already discussed, misinformed media coverage, and conflicting social and cultural values. Currently media coverage is arguably a key contributing factor to public understandings of climate change (Boykoff & Boykoff, 2007). Representations of climate change and scientific understandings of anthropogenic causes of climate change within the media are also significant to the development of public opinions on the issues. A UK study found the most common source of climate change/ global warming information as indicated by respondents was mass media (television 91.5 %, newspapers 85.1%, and radio 65.7 %) (Whitmarsh, 2009). An Australian survey found "respondents' willingness to take action against climate change—both at the individual and national level—is determined by their exposures to the mass media" (Akter & Bennett, 2011, p.18)

Boykoff and Boykoff (2007) argue journalistic practices, such as allowing equal weight to both scientist and sceptics, has erroneously given the impression of wide scale disagreement amongst scientists. “Mediarology” is a term used by the late Stephen Schneider (2005), in his attempt to understand the role media plays in climate change “denialism”, having stated that polarised viewpoints of ‘for or against’ is at odds with how science works. Science is “a spectrum of potential outcomes, oftentimes accompanied by a considerable history of scientific assessment of the relative credibility of these many possibilities” (Schneider, 2005, para 2). He believed scientists, reporters and citizens need to better understand each other’s paradigms, arguing scientists should work to better understand the public communication process, journalists should be made aware of the biases of misapplying balanced reporting, and citizens must take personal responsibility for educating themselves on both sides of the climate debate (Schneider, 2005).

Boler (2008) takes a different stand to Schneider on the role of media in public perceptions. Boler (2008) questions the role of media, power, and the coordinated effort focussed on the manipulation of public perceptions. Boler asks:

> Who has the power to define reality? The question of what is required to counter the sophisticated operations of dominant media in this era of unparalleled public perception management merely leads to the next question in the hall of mirrors: How is it that the changing whims of media and Politicians are able, through censorship, omission, explicit suppression of dissent, and perverse manipulation of facts, to manipulate publics?
>
> (2008, p.2-3)

Unlike Schneider who argued irresponsible journalistic practices were leading to a misrepresentation of climate science, Boler (2008) contends the media controls reality and purposefully aims to deceive and control the public.

The choice of language and terminology used when referring to climate change has been questioned as a strong influence on the way in which people respond to global concerns. Whitmarsh (2009) found the use of either climate change or global warming affected how the UK public understood and assessed climate concerns. The study found *global warming* was more often believed to have human causes and tended "to be associated with ozone depletion, the greenhouse effect and heat-related impacts, such as temperature increase and melting icebergs and glaciers" (p.416). The term *climate change* was found to be "more readily associated with natural causes and a range of impacts" (p.416). The phrase *global warming* generated significantly more concern by respondents than the term *climate change.* Further, more people believed individual or public action would be effective in addressing global warming than climate change. Conversely, a study undertaken in the US and across 31 European countries found no apparent difference in the perceived seriousness of the terms global warming and climate change, with the use of either term showing no impact on the perceptions (Villar & Krosnick, 2011).

Kahan, Jenkins-Smith and Braman (2011) argue that studies suggesting that poor media coverage, lack of information, or poor scientific understandings are the source of widespread public disagreement on scientific consensus on climate change are incomplete. They argue if a lack of scientific knowledge or awareness of scientific findings is the source of disagreement for example, we would see a steady rise in community consensus as more information was disseminated which is not the case (Kahan & Braman, 2006; Kahan et al., 2011). Kahan et al. (2011) contend individuals do not disagree about climate change (or other controversial topics such nanotechnology or disposal of nuclear waste) because one knows more about a topic than the other, rather individuals' cultural predispositions will shape their perceptions and beliefs about who the credible sources of knowledge are. As most individuals are unable to determine through personal investigation whether the climate is changing, they must turn to trusted sources of information to guide them. The cultural cognition thesis claims individuals ascribe greater credibility to expert knowledge sources they perceive as sharing their worldviews, while discrediting information sources whose worldviews they perceive to be different from theirs. They argue public disagreement surrounding the scientific consensus of climate change is not the result of individuals refusing to accept scientific opinion rather, culturally diverse people disagreeing on what the scientific consensus actually is. Individuals recognise or identify credible sources of knowledge as those sources that share their worldviews (Kahan et al. 2011). Further, the authors posited, when seeking information, individuals will "work harder" to source information that is “congenial to their cultural predispositions” (Kahan et al. 2011, p.5) and when confronted with a stated ‘expert source’ individuals may form biased assessments of the knowledge or authority of those sources. The result is an over representation of information that is agreeable to the individual’s values (Kahan et al., 2011).

Through a study administered online in 2009, Kahan et al. (2011, p.6) tested the hypothesis “that cultural cognition shapes perceptions of scientific consensus”. The stated goal of the study was to explain why members of the public failed to form beliefs consistent with scientific consensus. The study aimed to examine “whether subjects’ [individuals’] perceptions of an information source’s expertise is conditional on the fit between the subjects’ predispositions and the position that the putative expert espouses on a particular risk” (Kahan et al., 2011, p.6). The study found a strong correlation between an individual’s cultural values and their perceptions of scientific consensus (Kahan et al., 2011). Individuals holding hierarchical and individualistic views significantly disagreed about the state of expert opinion on various topics, including climate change, with individuals holding egalitarian and communitarian outlooks. The study also found participants identified knowledgeable and trustworthy experts based on a correlation between their cultural beliefs and those of the expert.

Further studies on trust and belief in climate science have shown ideological and political beliefs strongly influence the way in which individuals engage with climate change (Maibach, Roser-Renouf, & Leiserowitz, 2009). A U.S. study exploring the influence of political beliefs and ideologies on climate change belief identified six unique public responses to climate change. The report titled “Global warming’s six Americas 2009: An audience segmentation analysis” (Maibach et al., 2009) asserts the “six Americas” respond to the issues of climate change in their own distinct ways. The study also identified how values, political ideology, and religious beliefs were strongly linked to climate change beliefs. The groups that were more concerned about climate change tended to be more politically liberal and to hold strong egalitarian and environmental values. The less concerned groups were found to be more politically conservative, hold anti-egalitarian and strongly individualistic values, and were more likely to be evangelical with strongly traditional religious beliefs (Maibach et al., 2009, p. 24). The report identified the six Americas to be:

> The Alarmed (18%) are fully convinced of the reality and seriousness of climate change and are already taking individual, consumer, and political action to address it. The Concerned (33%) – the largest of the six Americas – are also convinced that global warming is happening and a serious problem, but have not yet engaged the issue personally. Three other Americas – the Cautious (19%), the Disengaged (12%) and the Doubtful (11%) – represent different stages of understanding and acceptance of the problem, and none are actively involved. The final America – the Dismissive (7%) – are very sure it is not happening and are actively involved as opponents of a national effort to reduce greenhouse gas emissions.
>
> (Maibach et al., 2009)

A variety of other studies have found environmental values and political affiliation were strong predictors of scepticism of climate change science (Malka, Krosnick, & Langer, 2009; Tranter, 2011; Whitmarsh, 2009). Whitmarsh highlights the ideological basis of the belief in and denial of climate change (Whitmarsh, 2009, p. 9), with high pro-environmental values and left of centre political beliefs correlating strongly with climate change belief and low pro-environmental values and right of centre political beliefs correlating strongly with sceptical or negative GW beliefs. Within Australia, Tranter (2011) analysed two nationally representative surveys, the 2007 Australian Survey of Social Attitudes (AuSSA) and 2007 Australian Election Study (AES), focussing on how social and political values influence support for environmental issues and climate change policy. Tranter (2007) found National Party and Liberal supporters were less likely to see climate change as a serious threat than Labor and Greens supporters.

2.1.4 Risk Perceptions

Also used as a measurement of understanding within climate change literature are risk perceptions or an individual's assessment of the perceived seriousness of the threat that climate change poses, as well as, perceptions relating to the urgency or serious of the threat and personal concern over threat to oneself and family (Leiserowitz, 2008).

In a study investigating climate change risk perceptions, beliefs, and willingness to act, O'Connor, Bord and Fisher (1999, p. 462) define risk perceptions as "the perceived likelihood of negative consequences to oneself and society from one specific environmental phenomenon" in this case global warming. The study investigated the link between risk perceptions and willingness to act on climate change. They found that risk perceptions and knowledge influence individuals' willingness to take action in relation to climate change, however, so do general environmental beliefs and other demographic characteristics. The authors concluded that although risk perceptions, beliefs and knowledge are related they appear to be independent predictors of behavioural intentions (O'Connor et al., 1999).

Risk is a social construct and "[r]isk assessment is inherently subjective and represents a blending of science and judgment with important psychological, social, cultural, and political factors" (Slovic, 1999, p. 699).There are two modern theories of risk and decision making that outline ways in which individuals assess risk and make choices: the analytic system and the experiential system (Slovic, Finucane, Peters, & MacGregor, 2004). The analytic system or *risk as analysis* relies on logic, reason, and deliberation in risk decision making (Slovic & Peters, 2006). The risk as analysis theory proposes that people assess the severity and probability of an outcome and use this information to make a decision (Loewenstein, Weber, Hsee, & Welch, 2001). This cognitive dimension of risk perception includes knowledge about the risk. In order to assess risk in relation to climate change an individual would need to have some 'knowledge' of current scientific projections relating to the likelihood and severity of climate change impacts. 'Accurate knowledge' about climate change has been reported as a significant influence on climate change risk perceptions (Milfont, 2012; O'Connor et al., 1999; Reser et al. 2012). Lack of knowledge about potential consequences can lead to lower risk perceptions even in areas that are at increased risk (Brody, Zahran, Vedlitz, & Grover, 2008).

In contrast, the experiential system or *risk as feelings* relies on intuitive or instinctive reactions to risk that are largely automatic (Slovic et al., 2004). Powerful emotions such as fear, anxiety and dread are argued to play a role in experiential risk assessment, however so too do less prominent feelings. Affect or the "faint whisper of emotion" (Slovic, Peters, Finucane, & MacGregor, 2005) is experienced as a conscious or unconscious positive or negative feeling

(Slovic et al., 2005). It is recognised analytic and experiential thinking are interactive, and rely on each other, with the analytic system being said to be ineffective unless guided by emotion and effect (Slovic et al., 2004). With experiential thinking being argued in recent times to be the dominant method by which humans assess and make decisions on risk (Slovic & Peters, 2006).

Perceived experience with climate change, for example changes in seasons or weather (Akerlof, Maibach, Fitzgerald, Cedeno, & Neuman, 2013), appears to increase perceived risk perceptions (Reser, Bradley, & Ellul, 2014). Policy preferences, however, are most strongly influenced by underlying values and world views (Leiserowitz, 2006). A third theory of risk perceptions argues worldviews and social values strongly influence risk perceptions. World views "entailing deeply held beliefs and values regarding society, its functioning and its potential fate" (Dake, 1991, p. 62) influence public perceptions of risk. Cultural theorists propose individuals choose what to fear to maintain a preferred way of life, and selective attention to risk and preferences for risk taking correspond to cultural biases (Aaron & Dake, 1990). This cultural theory of risk has been further advanced by the Yale Cultural Cognition Project. The "cultural cognition thesis" (Kahan & Braman, 2006; Kahan, Braman, Slovic, Gastil, & Cohen, 2007; Kahan et al., 2011) asserts "people's beliefs about risk are shaped by their core values" (Kahan et al., 2007, p. 2). As discussed in the previous section on beliefs, people who hold diverse cultural outlooks hold significantly opposed views about risks associated with issues such as climate change (Kahan et al., 2007). In essence, hierarchical and individualistic values or egalitarian and communitarian values exert substantially more influence over risk perceptions than any other characteristic (Kahan et al., 2007).

Risk perceptions are shown to be complex and multidimensional (van der Linden, 2015), however generally, women tend to judge risks to be higher than males, and white males' risk perceptions appear largely lower than all other groups (white females, non-white males and non-white females) in an phenomenon labelled 'the white male effect' (Finucane, Slovic, Mertz, Flynn, & Satterfield, 2000; Flynn, Slovic, & Mertz, 1994; Slovic, 1999). These white males assess risks to be low and tend to be hierarchical, individualistic and anti-egalitarian (Finucane et al., 2000). A study undertaken by Flynn et al. (1994) found a subgroup of white males, making up around 30% of their white male sample, held very low risk perceptions, this subgroup were more likely to be better educated, have a higher household income and be politically conservative (Flynn et al., 1994).

As highlighted in previous sections, many individuals living in developed countries are aware of climate change, however, many perceive the risks associated with a changing climate to be removed from them both physically and temporally (Lorenzoni et al., 2007), and as such view these risks as less important than other risks which appear closer to home (Lorenzoni & Pidgeon, 2006). However, a recent survey suggests the Australian general public perceive climate change and its impacts to pose a risk to their health and financial situations (Reser et al., 2012). Further the study found general concern about climate change to be high, with 71% of British and 66.3% of Australian respondents reporting feeling very or fairly concerned (Reser et al., 2012). Temporal pessimism was identified by Gifford et al. (2009) across 17 of the 18 countries included in a study investigating respondents' personal assessments of the current and expected future state of the environment. Australian respondents showed high levels of spatial optimism bias (positive assessment of current local environmental conditions in comparison to other countries), however, they showed the highest level of pessimism for the future in relation to environmental challenges (Gifford et al., 2009).

As with other parts of the world, Australian women are more concerned about the impact of climate change and more likely to agree that climate change poses a serious threat to Australians' way of life in the coming decades (Stefanova, Connor, & O'Halloran, 2014). More generally Australians feel climate change is likely to worsen and many feel concern that they or their family may be adversely affected by climate change (Agho, Stevens, Taylor, Barr, & Raphael, 2010). However a recent survey of over 5,000 Australians showed that climate change is a relatively low priority when compared to other general and environmental concerns such as employment, education, and water (Leviston et al., 2014). With the respondents ranking climate change at number 14 of 16 issues with only population and terrorism being ranked as less important (Leviston et al., 2014).

2.1.5 Responses

Responses to climate change include people's opinions or understandings about appropriate and effective reactions to climate change including personal actions and/or policy preferences. Understanding of climate change within this usage includes how individuals ascribe perceived responsibility for action, effectiveness of individual, collective and government actions, as well as preferences for a wait and see approach to action, a need for immediate and major action, or the enactment of the precautionary principle approach to uncertain risk (Leiserowitz, 2008).

Studies have found that large portions of the population who are aware of and accept climate change believe something should be done to minimise short and long term effects through adaptation and mitigation measures (Ashworth et al., 2011). Some studies have shown individuals have identified as feeling morally responsible to act on climate change even in the face of inaction by larger groups and government (Bulkeley, 2000). However these actions can be constrained by institutional factors with which individuals feel they have no control over (Bulkeley, 2000). In other words, perceived efficacy of individual actions may limit action taken on an individual scale.

Whitmarsh (2009) examined UK participants' impact oriented versus intent oriented climate mitigation actions. She found individuals who are acting with the intent of mitigating climate change are likely to be undertaking less effective mitigation actions such as reducing aerosol use rather than effective strategies. Although many of the respondent regularly undertook impact oriented climate change mitigation actions they were typically undertaken as they were financially rewarding and convenient, for example reducing energy consumption to save money, rather than with the priority of mitigating climate change. Actions that may require sacrifice, for example driving less, were seen to be less attractive (Whitmarsh, 2009).

Australians in general believe Australia should be taking action to respond to current and future climate change (Ashworth et al., 2011; Bulkeley, 2000) and the federal government should be taking the lead (McAllister, 2014), however many hold little hope of the government or the opposition government implementing an effective policy (Stefanova, Connor, & O'Halloran, 2014). Australians are supportive of government actions that are least likely to impose a financial burden (Ashworth et al., 2011) showing strong support for: increased research into renewable energy; ensuring future water supplies; working on environmental problems; and encouraging people to consume less; and little support for increased electricity or petrol prices (Ashworth et al., 2011).

Individuals may not be effectively responding to climate change due to structural barriers, including feeling there are limited options available (Howell, 2011) due to financial barriers or factors within the physical environment. Structural barriers can limit responses to climate change for many people, for example, those living in extremely cold climates may not be able to reduce heating energy use, and lack of public transport may limit the ability of others to reduce transport related energy use. Structural barriers to action on climate change in many cases must typically be addressed by forces outside of an individual's control, such as government policy. Psychological barriers also limit climate change mitigative responses. Gifford (2011) outlines a number of psychological barriers to action which have been categorised under seven main themes, which he names "*Dragons of Inaction".* They include: (1) limited cognition – including ignorance, optimism bias and perceived self-efficacy; (2) ideologies – worldviews; (3) comparisons with others – social comparisons, social norms and perceived inequity; (4) sunk costs – previous financial investments, habits and conflicting aspirations; (5) discredence – mistrust and or denial; (6) perceived risks – including physical, financial and temporal; and (7) limited behaviour – including tokenism and rebound effect (Gifford, 2011). He argues these barriers limit widespread action on climate change by individuals for whom such actions are feasible (Gifford, 2011).

2.1.6 Engagement

Responses to and engagement with climate change are related dimensions, however they are distinct in their usage within the literature. As outlined above, responses are focussed on people's opinions or understandings about appropriate and effective reactions to climate change, while engagement generally refers to an individual's attention to climate change, including active thinking about and interest in the issue, attention to individual actions, and personal connections. The notion of engagement has been defined as "a state of personal connection that encompasses cognitive, affective and/or behavioral dimensions" (Wolf & Moser, 2011), or what people feel, know and do. Lorenzoni et al. (2007, p. 446) explain further "[a] state of engagement is understood … as concurrently comprising cognitive, affective and behavioural aspects. In other words, it is not enough for people to know about climate change in order to be engaged; they also need to care about it, be motivated and able to take action".

Understanding and engagement are at times described as separate notions within the climate change literature, however, the two are interrelated and are not easily separated (Wibeck, 2013). Many argue that individuals have an important role to play in mitigating and adapting to climate change with individual and collective engagement essential (Wibeck, 2013). Wibeck (2013, p. 391) identifies two types of public engagement with climate change. The first includes public participation in climate science and political processes; this type of engagement promotes active involvement where individuals feel empowered and are actively involved in formal decision making coordinated by government institutions and other agencies (Few, Brown, & Tompkins, 2007). The second type of public engagement involves a more personal connection with climate change, one where the individual cares and feels motivated to act on climate change but does not necessarily involve active participation in policy making (Wibeck, 2013). It is important to note, knowing, caring, and doing are not related in a linear manner, that is increased knowledge does not necessarily lead to an increase in caring, leading to behaviour change (Kollmuss & Agyeman, 2002). Conversely, high levels of scientific literacy (Kahan et al., 2012), and/or and increased knowledge of climate change (Kellstedt, Zahran, & Vedlitz, 2008) have been shown to lead to higher levels of apathy in regard to climate change and lower feelings of personal responsibility.

An Australian study found Australians are generally not engaged with climate change at a community level, however larger numbers reported engaging in pro-environmental (although of limited impact) individual behaviours, including recycling, using environmentally friendly products, reducing water usage and switching off lights (Leviston et al., 2014), preferring home-based mitigative actions to those away from the home (such as carpooling or reduced travel) (Reser et al.,2012). Reasons for personal engagement with pro-environmental behaviours are complex and respondents to the Leviston (2014) survey revealed motivation differences. As cited above, in most cases individuals engaging in pro-environmental behaviours did so for reasons other than helping the environment with financial benefits being cited as the primary motivation (Leviston et al., 2014).

Lorenzoni et al. (2007) investigated barriers to individual engagement with climate change identifying knowledge, values, experiences, lifestyles and wider social context influencing the degree of individual engagement. They classified the key barriers that limit engagement as either personal or social. Personal barriers include: lack of knowledge; uncertainty and scepticism; distrust of information sources; externalising responsibility and blame; climate change being seen as a distant threat; having more important concerns; reluctance to change lifestyle; fatalism (i.e. it's too late to do anything); and feelings of individual helplessness (drop in the ocean). Perceived social barriers include: lack of political action; lack of action by business and industry; free rider affect (no one else is taking action); social norms and expectations; and a lack of enabling initiatives (i.e. existing infrastructure locks in current lifestyle).

Finally, the way in which climate change is communicated can also serve to limit personal engagement with the issue. Fear inducing or shocking images of climate change have been shown to increase an individual's concern over climate change, however the same images also tend to disengage individuals as they may leave them feeling disempowered and overwhelmed (Moser & Dilling, 2004; O'Neill & Nicholson-Cole, 2009). Individuals tend to feel more engaged with an issue when they feel informed about the risk, understand the extent of their vulnerability, have clear goals and strategies to reach their goals (Moser, 2007).

2.1.7 Teachers' climate change understandings

Although the general public's understandings of climate change have been the focus of various research, teachers' understandings of climate change have not seen the same emphasis. Research that has investigated teachers' understandings of climate change has predominantly focussed on teachers' knowledge of climate change and climate change science. Research investigating pre-service teachers' knowledge and understandings of climate change, for example, has shown misunderstandings surrounding environmental concerns (Boon, 2010; Papadimitriou, 2004). Boon (2010), for example, found pre-service teachers knew little about the greenhouse effect with only 11 percent within the sample (*n=107*) correctly answering the question "what is the greenhouse effect" (Boon, 2010, p.110). Further, the studied cohort of pre-service teachers showed a general confusion between the ozone layer and greenhouse effect.

Research investigating in-service teachers' understandings of climate change appears to be limited. However research on teachers' climate change science knowledge has indicated in-service science teachers hold misconceptions too. A study of science teachers in the US public school system found teachers hold misconceptions about climate change science and many do not believe that an emphasis should be placed on the scientific consensus of anthropogenic climate change (Plutzer, McCaffrey, et al., 2016; Wise, 2010).

Research investigating teachers' thinking about the teaching of climate change begins to provide more insight into their understandings about the issue. Research suggests teachers believe climate change is a controversial topic and are sensitive to the controversy surrounding climate change (Wise, 2010). A study from the US indicated science teachers view the controversial nature of the topic as an opportunity to develop critical thinking and discuss the nature of science (Monroe, Oxarart, & Plate, 2013). Further research suggests the perception of public controversy is likely to influence the content of lessons on climate change in other ways also, particularly in relation to human contributions. Wise (2010) argues that although teachers indicated they believed human actions had at least some influence on climate and that concerns about controversy or objections within their classrooms were small, they felt it important to teach 'multiple perspectives' on the issue (Wise, 2010). Along a similar line, a study just published in 2016 found science teachers may be presenting mixed messages about the causes of climate change by emphasising human activities as the primary source of climate change while simultaneously emphasising the idea that 'many scientists' attribute natural causes to recent climate change (Plutzer, Hannah, et al., 2016).

Other studies suggest teachers inform themselves about curriculum content areas they are unfamiliar with through various sources including other trusted teachers, the Internet, and the media (Buehl & Fives, 2009; Dupigny-Giroux, 2008; Wise, 2010). The media is viewed as one of the growing barriers to climate change education due to students and teachers being oversaturated and becoming bored with the topic and, perhaps more detrimentally, being exposed to the often poor representation of facts leading to the development of misconceptions (Robinson, 2011).

The above research suggests the ways in which teachers understand climate change may influence the ways they engage with the topic in their classrooms. Teachers appear to believe human influences are affecting the climate, however it appears they also believe the issue is controversial and requires engagement with multiple positions. As the above research suggests individuals' understandings are complex, teachers' understandings of climate change require further investigation.

2.2 Teacher beliefs

A number of scholars have highlighted the importance of investigating teacher beliefs and their relationship with teacher practice (Cronin Jones, 1991; Kagan, 1992; Munby, 1982; Pajares, 1992). It is suggested in the above review exploring the ways in which individuals and teachers understand climate change that teachers may hold complex and at times contradictory understandings about climate change which appear to influence their practice. Below I will examine literature that explores the ways in which teacher beliefs may influence their teaching practice and curriculum choice, followed by a closer inspection of literature focussed on teacher beliefs about the teaching of controversial issues.

2.2.1 Teacher beliefs 'a messy construct'

Understanding the role that teacher beliefs play in curriculum choice and teacher behaviour is complicated by the way in which belief is defined in the literature. The lack of a clear distinction between beliefs and knowledge is the cause of some confusion (Pajares, 1992). The division between the two constructs, as argued by Pajares (1992), varies according to how the researcher chooses to operationalise them.

Researchers investigating teacher practice have argued knowledge influences teacher practice more often than teacher beliefs (Elbaz, 1983; Roehler, Duffy, Hermann, Conelly, & Johnson, 1988). Roehler et al. (1988), for example, assert that it is not a teacher's beliefs or theories that effect teaching practice but the way in which the teacher organises instructional knowledge (which could be treated as pedagogical content knowledge). They argue a teacher's beliefs influence what is said outside of the classroom, but a teacher's knowledge structure is what determines what happens within the classroom. This definition has been challenged by other research however (see section 2.2.1).

Elbaz (1983) also refers to teacher knowledge as influencing teaching practice. Personal practical knowledge or all that a teacher 'knows' is described as wide-ranging and expanding with experience. Elbaz incorporates all a teacher knows about student learning styles, strengths, and needs, as well as a repertoire of instructional and classroom management techniques, in personal practical knowledge. Further incorporated into a teacher's personal practical knowledge is an understanding of the social structure of the school, what is required for the success and survival of both teacher and student, as well as an understanding of the community that the school is a part of, including what the community will accept and what it will not (Elbaz, 1983). Elbaz (1983) argues this experiential knowledge is informed by the teacher's theoretical knowledge as integrated by the teacher in terms of personal values and beliefs.

A distinction between beliefs and knowledge has been argued based on the variability afforded to each, with beliefs viewed as more resistant to change. Roehler et al. (1988), for example, maintain knowledge is emotionally neutral while remaining fluid and evolving while beliefs are static and unchanging and associated with an "emotional aura of rightness and wrongness" (Roehler et al., 1988, p.160). Similarly when making a distinction between knowledge and belief, Nespor (1987) claimed knowledge accumulates and changes whereas beliefs are relatively static.

However a clear distinction between beliefs and knowledge remains difficult to establish, with researchers failing to identify a clear and consistent definition of beliefs within the literature (Eisenhart, Shrum, Harding, & Cuthbert, 1988; Fives & Buehl, 2012; Kagan, 1992; Pajares, 1992). In a review of the literature on teacher beliefs and educational research Pajares (1992) noted defining teacher beliefs was a "game of player's choice" (p.309). More recently Five and Beuhl (2012) also argue a difficulty in authors consistently defining teacher beliefs. Pajares (1992, p.308) reasoned that for research on teachers' beliefs to become viable and rewarding researchers must decide "what they wish belief to mean and how this meaning will differ from other constructs". Educational research literature has tended to use many terms interchangeably with beliefs including attitudes, values, ideologies, perceptions, judgements (Pajares, 1992), principles of practice, personal epistemologies, perspectives, and orientations (Kagan, 1992). Teacher beliefs have been defined as "a teacher's idiosyncratic unity of thought about objects, people, events and their characteristic relationships that affect his/her planning and interactive thoughts and decisions" (Mansour, 2009, p. 26), and elsewhere as a teachers' "implicit assumptions about students, learning, classrooms, and the subject matter taught" (Kagan, 1992, p.66).

As no one accepted definition of 'teacher belief' has been used consistently throughout educational research literature there has been limited cumulative development of the concept (Eisenhart et al., 1988; Fives & Buehl, 2012). Kagan (1992) argued research concerned with teacher beliefs is a cluster of separate research agendas with much of the research in the field focussed on specific subject beliefs (i.e. beliefs about teaching math). Similarly Nespor (1987) has argued research investigating teacher beliefs and how they influence practice have been either too broad or too narrow to be of any practical use for generalisation or comparison.

Pajares (1992, p. 316) also reasoned that the construct of educational beliefs is too broad and encompassing for the purposes of research and argued that educational beliefs require clarification and should be conceptualised as "educational beliefs about". Such beliefs, for example, include confidence to affect student outcomes (teacher efficacy), about confidence to perform specific tasks (self-efficacy), about the nature of knowledge (epistemological beliefs), and beliefs about subjects or disciplines (reading/writing instruction) (Pajares, 1992).

Pajares (1992, p. 326) however warns against researchers limiting investigations of teacher beliefs to professional beliefs about teaching, arguing "seeing educational beliefs as detached from and unconnected to a broader belief system is ill advised and probably unproductive". This broader belief system has been referred to as a teacher's worldview. A worldview as defined by Cobern (1994, p. 5) "provides a person with presuppositions about what the world is really like and what constitutes valid and important knowledge about the world". Cobern (1993, p. 2) further argued worldviews are fundamental beliefs about the world, which "exert a powerful influence on how sense is made of events in the world".

Despite the apparent inconsistency in the defining and classification of beliefs in educational literature, the importance of teachers' beliefs has been identified (Fives & Buehl, 2012; Pajares, 1992). Teacher beliefs have been examined in the literature including teacher and teaching efficacy beliefs (Riggs & Enochs, 1990; Tschannen-Moran & Hoy, 2001; Tschannen-Moran, Hoy, & Hoy, 1998), teacher epistemological beliefs (see for example Luft &

Roehrig, 2007), teacher pedagogical beliefs (see for example Ertmer, 2005) and subject specific beliefs (see for example Bryan, 2003; Stipek, Givvin, Salmon, & MacGyvers, 2001). Pajares (1992) offered 16 “fundamental assumptions” (p. 324) that he argued can be reasonably made when initiating research on teachers’ educational beliefs. He argued these inferences and generalisations could be made with reasonable confidence given the confidence afforded them in a reasonable number of findings. From Pajares’ (1992) synthesis of teacher belief research it can be understood with reasonable reliability that teacher beliefs are relatively fixed, with little change likely even in the presence of new reliable information. Beliefs are formed early, with teaching beliefs being well established before commencing pre-service teacher education. Further, teacher beliefs and knowledge are intertwined; however, beliefs act as a filter for new understandings and act as powerful influences over teacher behaviour, influencing decisions and actions as well as perception.

Fives and Buehl (2012) argue researchers have justified the significance of examining teacher beliefs through their importance as filters, frameworks for decision making, or as guides. Filters they contend have been argued to influence how individuals interpret new information and what teachers recognise as worth discussing with students. Beliefs also provide frames from which teachers view problems or tasks. These frames can influence the teaching approaches used and may be most prominent during planning and reflection. Lastly, beliefs as guides influence immediate action and include self-efficacy beliefs and task value. They argue beliefs may serve different functions depending on the situation however systematic theoretical and empirical work is still needed to investigate the role and influence of different beliefs (Fives & Buehl, 2012).

2.2.2 Teacher beliefs and curriculum choice

Although there appears to be a strong link shown in the literature between teacher beliefs and teacher behaviour, it has been argued researchers investigating the implementation of curriculum have focussed little on the role of teacher beliefs on curriculum choice (Cotton, 2006a; Cutter-Mackenzie & Smith, 2003; Nespor, 1987). In the past, according to Shulman (1986, p. 8), how teachers decide what to teach was part of “the missing paradigm” within teacher research. Current research literature indicates teacher beliefs about how students learn, the ability levels of students, their own self-efficacy as teachers, educational discourses, their role in the classroom, and the relative importance of content topics, do influence how intended curriculum is implemented as well as what beyond the intended curriculum may be taught. In this way teachers act as “curricular- instructional gatekeepers” (Thornton, 1989, p. 5) to what and how students learn.

Teacher beliefs concerning their ability to teach subject matter influences decisions about the inclusion of that topic within their classrooms (Wise, 2010). Lack of understanding or knowledge surrounding a subject matter to be taught can lead to a topic being avoided by teachers or to be covered poorly or incorrectly (Wise, 2010). Topic knowledge further influences teaching practice though student questioning and classroom interactions. For example, teachers with low subject knowledge may rely too heavily on lower order questioning or questioning that requires recall of topic knowledge, while more knowledgeable teachers ask higher order, more abstract questions (Hashweh, 1987).

Lack of knowledge surrounding a topic leading to avoidance has been linked to teaching efficacy beliefs. Teaching efficacy beliefs have been shown to be an important indicator of teacher curriculum choice and have been identified as a “variable accounting for individual differences in teaching effectiveness” (Gibson & Dembo, 1984, p.1). Self-efficacy is a social cognitive theory developed by Bandura that describes individuals’ beliefs in their ability to “organise and execute courses of action” (Bandura, 1997, p.3) to reach a desired result. Bandura and Adams (1977) explain further that “perceived self-efficacy affects choice of activities and behavioral settings, how much effort they expend, and how long they will persist in the face of obstacles and aversive experiences” (pp.287-288).

Bandura (1997) emphasised the importance of teaching efficacy in arguing that the amount of effort a teacher is willing to expend is directly related to what they believe they can accomplish. For example, studies investigating science teaching in primary schools have highlighted that teachers with low confidence and interest in science rarely teach science, and those that do, rely on the use of text books and worksheets or science activities that are manageable and predictable (Appleton & Kindt, 2002; Davis & Smithey, 2009; Enochs & Riggs, 1990).

Together with beliefs about personal ability to implement curriculum, dominant educational discourses such as those concerning the role of education and the role of a teacher can serve to constrain teachers (Barrett, 2006; Cronin Jones, 1991). Barrett disputes the common notion that if a teacher believes in a certain pedagogical approach or is motivated to care about an issue then the teacher will feel inspired to use the approach or make curriculum choices that explore those issues. Barrett (2007, p. 215) contends "the power of dominant discourses, (re)inscribed through everyday language and social practices", may act to constrain teachers from taking actions they believe in. Educational discourses of what it means to be a teacher and the idea that education must be neutral can have "powerful effects on a teacher's ability to see beyond what they think it is possible to do" (Barrett, 2006, p.508). Stevenson (1987) argues the established purposes and structures of schooling can act to discourage or limit teachers wishing to incorporate environmental education (as represented in international policies and discourses) in their curriculum. The rhetoric reality gap within environmental education, as argued by Stevenson, is to be expected given the traditional purpose, structure, and culture of schooling. He argues that the political nature and socially critical goals of environmental education can be contrasted with the uncritical role of schooling which focuses on cultural reproduction and the maintenance of the social order. Students engaging in ideological and critical inquiry conflicts with the dominant practices in schools which emphasis assimilation and reproduction of simplistic factual knowledge and unproblematic truth (Stevenson, 1987). Dominant discourses of legitimate knowledge and contradictory subjectivities (Barrett, 2006) may act as a barrier or undermine teachers who wish to implement curriculum that is viewed as deviating from this ideal. Barrett (2006, p. 216) states "some knowledge claims get to have authority while others are excluded, or deemed illegitimate".

Further to the dominant educational discourses of schooling, teachers have their own personal teaching philosophy, theories of education, and beliefs about their role as an educator through which all new policies are filtered (Stevenson, 1987). A teacher's beliefs about a 'teacher's role' take precedence over the specified aims of education and syllabus outcomes, and "[i]n this way, the teachers' beliefs act as a critical mediating factor between the syllabus and the classroom" (Cotton, 2006a, p.80). Roehrig, Kruse and Kern (2007) explored how teachers' educational beliefs affected the implementation of intended curricula. Roehrig et al.'s study examined how teacher beliefs influenced the implementation of science curricula reforms, specifically the implementation of an inquiry based chemistry curriculum. Through classroom observations and standardised teacher belief interviews (TBI) the authors found teaching beliefs have a significant impact on teaching practices and curriculum implementation. Teachers who held similar beliefs to those espoused within the reform based curriculum implemented the curriculum as intended, while those who held opposing or conflicting views found implementing the curriculum a challenge. The researchers observed that all teachers within the study stated that they were implementing the intended curriculum although from observations a wide variety of practices were identified.

Teachers find it difficult to implement intended curriculum that does not align with values they hold (Cotton, 2006a, 2006b; Cronin Jones, 1991; Roberts, 1982). A case study by Cotton (2006a) investigated how teacher beliefs impacted on the teaching of controversial environmental issues within high school classrooms. The study found that regardless of personal environmental beliefs, the teachers in the study felt offering a balanced picture of the issues surrounding a topic was important. The teachers aimed to include many different perspectives and allow students to develop their own attitudes and understandings whilst taking a neutral teacher role. However the ideal of taking a balanced and neutral approach to controversial issues was found to be problematic as, even with the expressed intent of taking the position of neutrality and balance, the influence of the teacher's own beliefs was greater than intended (Cotton, 2006b).

Teachers' political beliefs have also been shown to influence what they chose to teach and how they implement their curriculum (Cotton, 2006a, 2006b; Gudmundsdottir, 1990; Hess, 2004; Stevenson, 2010). Hess (2005) argues it is important for teachers to consider how political views shape our understandings of the nature of the controversial issue. Hess (2005) identified four approaches to teaching controversial issues based on how political views shape teachers' thinking. The first approach outlined is denial. Denying an issue is controversial allows a teacher to speak the truth and not be seen as taking sides. The second approach is the privileging of a particular preferred perspective. The third approach described by Hess is avoidance which occurs when teachers believe an issue is controversial and decide not to include it within their curricula. The final approach outlined is balance which is described as teaching a topic without favouring a particular perspective.

As the literature above highlights teachers hold a number of beliefs that may influence their practice. The literature examines teacher beliefs about education, learning, legitimate knowledge, the role of schools as well as broader worldviews or beliefs outside of their profession which influence decision making and curriculum choice within the classroom. What a teacher believes about the curriculum to be taught appears to play a significant role in if and how the subject matter is treated. Further, teachers' personal beliefs about the content to be taught influence teacher behaviour regardless of intention (Cotton, 2006; Hess, 2004).

2.2.3 Controversy in the curriculum

Topics that involve conflicting values, ideals and assumptions that significant numbers of people are seen to disagree on, are regarded as controversial issues (Cotton, 2006; Dearden, 1981; Oulton, Dillon, & Grace, 2004). Stradling (1985, p. 2) uses the term controversial issue for "those problems or disputes that divide society and for which significant groups within society offer conflicting explanations and solutions based on alternative values". Disagreements can be about the causes or consequences of something, appropriate action to take, or a desirable outcome (Stradling, 1985). Similarly, Bailey defined an issue as controversial "if numbers of people are observed to disagree about statements and assertions made in connection with an issue" (Bailey, 1975, cited Dearden, 1981, p.38). Dearden (1981) argues against Bailey's observational criterion for what is controversial asserting much of the social disagreement reflects "simple ignorance or else mere undisciplined assertiveness" (p.38). Noting children arguing over capital cities of countries as an example of where there appears to be disagreement when, in fact, there is a publicly known and available answer. Secondly, Dearden argues that regardless of the ungroundedness, inconsistency or invalidity of counterclaims, by Bailey's definition, all that is needed is a number of people to assert a counter opinion in order to render something controversial (Dearden, 1981).

Dearden suggests an alternate "epistemic criterion of the controversial" as "a matter is controversial if contrary views can be held on it without those views being contrary to reason" (1981, p.38). Further clarifying;

> By 'reason' here is not meant something timeless and unhistorical but the body of public knowledge, criteria of truth, critical standards and verification procedures which at any given time has been so far developed. It follows that what at one time is controversial may later be definitely settled, as with many opinions about the nature of the surface of the Moon and the character of the side that faces away from the Earth. At one time these were matters of legitimate dispute in a way which at least some of them no longer are.

Dearden outlines a range of 'types' of controversial issues. The first type outlined consists of issues that currently have insufficient evidence to settle them. The first type may be resolved as further evidence becomes available. A second type is where the "consideration criteria is clear but the weight given to them is not" (Dearden, 1981, p.39), or where information is given different weight or value by competing interests. A third is when there is no agreement of individual criteria amongst groups or individuals on an issue. The last is when whole frameworks of understanding are different. Dearden's example of the fourth 'type' is "the controversy between the religious believer and nonbeliever over the correct description of a great many things in the world" (1981, p.39).

If Dearden's (1981) definition is accepted then matters agreed to be known and understood with a high degree of certainty can no longer be classified as controversial even in the presence of social disagreement. With this understanding individuals or groups asserting lack of knowledge or understanding in the presence of reputable agreement of knowledge understanding would be seen to stating views contrary to reason and as such not render the matter as controversial.

Dearden clarifies by outlining a range of 'types' of controversial issues. The types outlined include, issues that have insufficient evidence to settle a controversial issue though the issue may be settled as further evidence becomes available. Second, where the "consideration criteria is clear but the weight given to them is not" (Dearden, 1981, p,39) or where information is given different weight or value by competing interests. Third, when there is no agreement of individual criteria amongst groups or individuals of an issue.

Last, when not only individual criteria is not agreed upon but whole frameworks of understanding are different. Dearden's example of the fourth 'type' includes "the controversy between the religious believer and nonbeliever over the correct description of a great many things in the world" (1981, p.39).

With Dearden's clarification the issue of anthropogenic climate change may be viewed as uncontroversial. As the National Academies of Science from 80 countries have issued statements endorsing the consensus position (Cook et al., 2016) that humans are causing the Earth's climate to change, those stating the science of climate change is contentious amongst the scientific community and the science of climate change is not robust do so contrary to reason. However, this distinct dichotomy does not adequately define in the current world climate and thinking surrounding anthropogenic climate change. To say anthropogenic climate change is not controversial is misleading, as the issue is the centre of many public, private and political debates. It can be said by Dearden's definition that anthropogenic climate change is controversial as people place different weight and values on the information and consequences outlined by science. Controversial issues are often divisive because "attitudes to the issues are based on value judgements, which in turn may be based on moral codes or related to ethical principles held by the individual" (Oulton et al., 2004, p. 414).

The inclusion of controversial issues within formal schooling can aid the development of skills and processes required for effective judgment and decision making (Hess, 2004). Making spaces within classrooms to discuss issues that are deemed controversial due to a lack of public consensus (Dearden, 1981), for example, allows students to gain skills such as negotiating differences and evaluating various positions, students can "learn to weigh up evidence, to search for information, to detect bias, to question the validity of sources and to present their own considered viewpoint" (Wellington, 1986, p. 4). The inclusion of controversial issues within classrooms has been viewed as an important way to prepare students for successful participation within society, with the discussion of controversial issues promoting democratic thinking and other forms of political engagement (Hess, 2004). Hess (2004) asserts schools are particularly suitable venues for discussing controversial issues, arguing schools have a greater capacity for the discussion of controversial issues due to the ideological diversity of classrooms making for powerful dialogue spaces.

The inclusion of controversial issues within classrooms, however, is not unproblematic with the more contemporary the issue the greater the potential for pressure on teachers (Stradling, 1985). Obstacles to the inclusion of controversial issues include: school community pressure for teachers to avoid topics which may encourage conflict or that may create controversy (Hess, 2004), lack of resources for use in the classroom (Cross & Price, 1996), conflicting stances about the purposes of education, fears that teachers or schools may be indoctrinating students, and a lack of agreement concerning what issues should be included in the curriculum and what excluded (Hess, 2004).

Whether a controversial issue is taught as an open topic that allows for multiple perspectives and various viewpoints, or closed with one perspective promoted is a “definite epistemic commitment” (Dearden, 1981) from the teacher. The teaching of controversial issues is often framed in terms of neutrality, balance and commitment (Cotton, 2006, Hess 2009, Stradling, 1985). Teacher neutrality can take one of four positions: exclusive neutrality; exclusive partiality; neutral impartiality; and committed impartiality. Exclusive impartiality takes the position that issues which are deemed controversial by the wider community should not be introduced into a school’s curriculum (Kelly, 1986). The argument for this type of treatment of controversial issues is based in the notion that schools are or should be nonpartisan and independent of any particular point of view. Hess (2005) refers to this position as avoidance. Avoidance can occur, according to Hess (2005), for two reasons. In some cases teachers are forbidden to discuss certain topics or are fearful of community response to certain topics. However, more prevalent, according to Hess (2005), is the influence of the teachers’ own views on certain issues. Strong personal views about issues can lead teachers to not include the topic within their classrooms due to the inability to provide a ‘balanced’ perspective. However Kelly (1986, p. 116) critiques the view that teachers and schools should avoid controversy for the sake of impartiality arguing it is impossible for schools or teachers to remain value free and uncontroversial stating “the search for a curriculum which maintains exclusive neutrality toward controversial issues is a futile and misguided enterprise”. Even when teachers choose to avoid controversial topics they cannot avoid the unintended impact of their practices (Kelly, 1986).

Exclusive partiality is described as the promotion of one point of view as the truth or as correct with other perspectives disregarded. Teachers may take this position to purposely privilege a certain perspective (Hess, 2005) because they feel it is their duty within a particular context, be that religious, moral, political or social, within which they teach, or they may feel exclusive partiality is necessary to correct "pervasive distortions perpetuated by dominant social norms and practices" (Kelly, 1986, p.117) for example, feminism, or anti-racism. This position is not always assumed purposefully however, some teachers may not be aware of dissenting positions on the issue and therefore present a familiar position as the only one. Whether purposefully or not the result of exclusive partiality is a one sided presentation of the issue. Although accepting this position does hold some value in a traditional curriculum where many voices are neglected, Kelly (1986) critiques this notion on its intellectual, practical and moral shortcomings.

A third approach to neutrality is neutral impartiality (Kelly, 1986), procedural neutrality (Stradling, 1985) or balance (Hess, 2005).This stance involves teachers presenting all relevant positions on an issue while remaining impartial and silent on their own views. This position, Kelly (1986) highlights, is supported by a number of educators and scholars. Kelly considers six reasons or factors influencing educators to take this stance including:

1. The public service orientation, where teachers' role is seen as the efficient and technically competent executor of the curricular choices of others, where "personal points of view on controversial issues [are relegated] to a minor, if not irrelevant, status" (Kelly, 1986, p. 123).

2. Liberal pluralism or the ideal that human diversity is a social good. Classrooms are seen as important spaces for the inclusion of diverse ideas and values, and teachers are to be nonpartisan referees supporting equal space for all viewpoints. Any influence by the teacher is seen as unprofessional and exploitive use of power.

3. Political prudence, avoiding the risk of litigation, unwanted conflict or accusations of indoctrination, prejudice or bias.

4. Ethical relativism with the general view that all values are of equal worth, what is right or good is subjective and there is no objective standard from which to judge the value of one position over another.

5. Ambivalence, ignorance or an uncertainty over one's own position on an issue leading to a sense of shame, therefore to protect the sense of authority figure neutrality is embraced as an ideal educational stance on the issue.

6. Rationalist perspective – the idea that "some arguments, rooted in more universal principles, are superior to others" (Kelly, 1986, p. 124) and the truth or rightness of these ideas can be easily deducted through the logical examination of evidence without the teacher's "superior power and authority" (Kelly, 1986, p.126) unintentionally limiting students' own critical rationality.

Kelly critiques the notion of neutral impartiality stating teacher viewpoints may have limited influence within "a pluralistic society, [where] youth are subjected to a number of diverse and conflicting influences" (Kelly, 1986, p.126) including home, peers and media. Teachers not revealing their point of view can lead to distrust where students can feel "manipulated, [and] mislead" (Kelly, 1986, p.127).

The final position on teacher neutrality is committed impartiality. Committed impartiality involves two ideas, the first is teachers should state their own point of view on controversial issues while, second, ensuring competing views receive a fair hearing (Kelly, 1986). This approach attempts to counter criticisms of indoctrination by arguing teachers disclosing their position on an issue is not the same as actively trying to convince students that their point of view is the correct one. McAvoy and Hess (2013) argue it is never appropriate to purposely try and coerce or convince students to adopt one point of view over another in open policy questions. Directive teaching is different from disclosure. Directive teaching has as its aim to encourage or persuade students to take a particular point of view on a topic, where disclosure is simply a teacher disclosing her view on a topic without trying to persuade students of her point of view.

To disclose or not disclose is a "pedagogical tool that requires the teacher to use good judgement" (McAvoy & Hess, 2011, p. 3). Disclosure, it has been argued, should be used wisely, teachers should not use their position to push a certain political position or point of view, nor "take potshots at political leaders with whom they disagree" (McAvoy & Hess, 2013, p. 42). Further, when discussing controversial issues teachers need to be both seen to be and in reality creating a politically fair classroom (McAvoy & Hess, 2013, p. 43). Disclosure teachers regularly share their views on a controversial topic and non-disclosures include teachers who attempt to stay neutral or see neutrality as the best policy.

Hess (2009) identified two areas that concerned teachers and students about disclosure of personal view by teachers. The first was 'ideological influence' and the second 'pedagogical influence'. The influence concerns were based on the idea that teacher views or beliefs about an issue would influence the opinions of students. Hess' (2009) study found 45% of teachers and 44% of students felt that if teachers shared their views about an issue students would be more likely to adopt the same view. Although, interestingly, only 23% of the same students believed a teacher disclosing their point of view would influence their own thinking about a topic. The study also found students were happy for teachers to disclose their point of view as long as they were not seen to be "'preaching,' 'pushing,' or 'forcing' their opinion without giving serious consideration to competing points of view" (Hess, 2009, p.102). One way students felt teachers allowed for disclosure without indoctrination was being "open to disagreement" (Hess, 2009, p.102) open minded and accepting of various viewpoints as well as a balanced approach to classroom materials.

Science teachers have been said to be particularly guilty of misrepresenting science as unproblematic, value free and non-controversial (Wellington, 1986, p. 3). Oulton et al. (2004, p. 412) argue science teachers need to take into account the nature of controversial scientific issues and emphasise within their teaching that

1. Groups within society hold differing views about them.
2. Groups base their views on either different sets of information or they interpret the same information in different ways.
3. The interpretations may occur because of the different way that individuals or groups understand or 'see' the world (i.e. their worldview)
4. Differing worldviews can occur because the individuals adhere to different value systems.
5. Controversial issues cannot always be resolved by recourse to reason, logic or experiment.

6. Controversial issue may be resolved as more information becomes available.

In summary, the importance of teacher beliefs has been well established (Fives & Buehl, 2012; Pajares, 1992). Teacher beliefs can be conceptualised more broadly than beliefs about teaching or practice alone to incorporate a teacher's worldview, or all that a teacher presupposes about the world. These worldviews comprise beliefs about: self, including efficacy, identity and role; context, including school climate and culture as well as relationships with colleagues, administration and parents; content knowledge; specific teaching practices and approaches; and students (Fives & Buehl, 2012). Teacher beliefs have been argued to act as filters for interpretation, frames for defining problems or guides or standards for teacher practice (Fives & Buehl, 2012). As such it has been argued teacher beliefs exist as integrated complex systems and must be considered in terms of their connections (Fives & Buehl, 2012; Pajares, 1992).

While the topic of teacher beliefs appears to have been explored in much detail there appears to be a number of important gaps. This research will begin to fill one such gap. By conceptualising teacher beliefs as teacher worldviews, this research will focus on the influence of teachers' understandings of climate change and their beliefs about climate change education on teacher practice.

2.3 Climate change education

Turning now to consider some of the ways climate change education has been conceptualised within the literature, it is my aim to develop a broad understanding of the emerging field. The following review will inform data analysis and discussion around teacher conceptions and practices of climate change education.

Climate change is a 'wicked problem' that sits at the nexus of science and society, where knowledge is incomplete or contradictory and no 'right' solution or best way forward is evident (Rittel & Webber, 1973). The invisible, uncertain, temporal and contested nature of climate change presents challenges to education and education systems founded on "simplistic factual knowledge and an unproblematic 'truth'" (Stevenson, 1987, p. 140). Some argue current educational practices are ill equipped to respond to the challenge (Kagawa & Selby, 2010a). Even so, education is understood as an imperative for successfully living in, and positively influencing, a future shaped by climate change (see for example: Kagawa & Selby, 2010c; Schreiner, Henriksen, & Kirkeby Hansen, 2005; United Nations, 1992; United Nations Educational Scientific and Cultural Organization (UNESCO) & United Nations Environment Programme (UNEP), 2011).

Climate change education has been described by McKeown and Hopkins (2010) as comprising two parts: Climate and Change. 'Climate' they explain involves the natural sciences while 'change' or educating for change involves engaging the social sciences and humanities. Taking this characterisation of climate change education and expanding upon it, this section will explore how climate change education has been conceptualised within the literature and ways in which schools, teachers and students may engage with climate change within their classrooms. This review forms the conceptual framework from which to explore teachers' conceptions and practices of climate change education.

2.3.1 Climate education.

In preparing young people to make informed decisions about climate change, some argue knowledge of what is currently scientifically understood about the issue is essential (Schreiner et al., 2005). Climate literacy has been described as an "understanding of your influence on climate and climate's influence on you and society" (U.S. Global Change Research Program, 2009, p. 2). A climate literate person has been defined as someone who "understands the essential principles of Earth's climate system, knows how to assess scientifically credible information about climate, communicates about climate and climate change in a meaningful way, and is able to make informed and responsible decisions with regard to actions that may affect climate" (U.S. Global Change Research Program, 2009, p. 2). Scientific knowledge is one of the most valuable resources we have when attempting to comprehend the atmospheric changes taking place and what the consequences of those changes are and may be. It has been argued climate change science literacy can empower individuals to be able to make reasoned, informed decisions about issues which aid in and improve quality of life (Bangay & Blum, 2010; U.S. Global Change Research Program, 2009).

The US Global Change Research programs guide: *Climate literacy: the essential principles of Climate science (2009),* organises climate literacy under seven essential principles:

1. The Sun is the primary source of Earth's energy for Earth's climate system.
2. Climate is regulated by complex interactions among components of the Earth system.
3. Life on Earth depends on, is shaped by, and affects climate.
4. Climate varies over space and time through both natural and man-made processes.
5. Our understanding of the climate system is improved through observations, theoretical studies, and modeling.
6. Human activities are impacting the climate system.
7. Climate change will have consequences for the Earth system and human lives.

Building off this framework, Shepardson et al. (2011) present a climate system framework for teaching about climate change from a systems approach which emphasises the relationship between the components of the climate system. At the centre of these climate science literacy learning frameworks is a basic understanding and appreciation of the Earth's climate as a system with interconnections and feedbacks (Shepardson, Niyogi, Roychoudhury, & Hirsch, 2011) and fundamental to this system is the balancing of the Earth's energy budget (Shepardson et al., 2011).

Any climate change will have consequences for the Earth system and human lives (U.S. Global Change Research Program, 2009). Increasing understandings of what is happening to the climate, the driving forces of climate change, that life on Earth depends on, is shaped by, and effects climate (U.S. Global Change Research Program, 2009), and fostering a mindset of alertness or attentiveness to climate change (Anderson, 2010) is a necessary component of climate education. Alongside increasing student knowledge about the issue, students also require skills to evaluate evidence and analyse data and the opportunity to develop the skills needed to use this information to make informed, well-reasoned decisions (Shepardson et al., 2011). By asking and examining questions such as what is evidence? students can learn to identify and assess scientifically credible information (U.S. Global Change Research Program, 2009). Climate science education also encourages students to examine human impacts on the Earth system and how human activities are impacting the climate including the impact of an increasing use of electricity and the role of the combustion of fossil fuels (Schreiner et al., 2005).

Australian research suggests students at primary, secondary and tertiary education levels hold various misconceptions and limited understandings about climate change (Boon, 2010; Skamp, Boyes, & Stanisstreet, 2013; Taber & Taylor, 2009). It is important to recognise and address misconceptions surrounding climate change science held by students or the general public. Education can help students to fill in 'missing links', and to understand the complexities of climate change science including the limitations of climate models (Schreiner et al., 2005). However, while scientific understandings are important, alongside these understandings students must also face the social realities of a changing climate. Climate change brings much complexity and uncertainty, and adequate responses to climate change, its impacts and implications, will require more than scientific knowledge alone.

2.3.2 Climate 'change' education.

Climate change education is frequently focussed on scientific-technical knowledge (Gonzalez-Guardiano & Meira-Cartea, 2010), which often stems from the belief that the transmission of scientific content and an increase in knowledge will lead to changes in values, attitudes and behaviour (Kollmuss & Agyeman, 2002). While it is assumed by some that 'sufficient' scientific knowledge is necessary to be able to meet the challenge of climate change (Schreiner et al., 2005), it is also understood learners must develop the capacity to become empowered to live within uncertainty, to reduce vulnerability and to enhance livelihoods. Learning for climate change must move beyond comfortable certainties and right answers (Selby, 2008) to develop the capacities that enable students to think critically and compassionately, solve problems and address uncertainty (Bangay & Blum, 2010).

Climate change raises more questions than science knowledge alone can answer (Monroe et al., 2013) and while climate education would traditionally be taught in geography and various science disciplines (McKeown & Hopkins, 2010), educating for change or 'change' education will require engaging all disciplines. As climate change is a wicked problem where our knowledge is incomplete and solutions are complex and contested, educational strategies must nurture learning where the information receiver "becomes a subject-interpreter and subject-social actor" (Gonzalez-Guardiano & Meira-Cartea, 2010, p. 29). Climate change requires learning that is creative, reflexive and a participatory process that supports learners to develop competencies that are transferable to new, uncertain and as yet unknown, or poorly defined, situations (Wals, 2011).

2.3.2.1 Emotional responses

While it is imperative that educators focus on developing learning spaces that address the implications of an uncertain future while avoiding dread or fear, increased knowledge and awareness about climate change will likely lead to increased concern amongst students (Taber & Taylor, 2009). Research suggests there may already be high levels of concern about climate change among young people (Corner et al., 2015). Confronting denial, addressing despair and working through grief are argued as necessities for truly significant contributions to learning about climate change (Selby & Kagawa, 2010). Hicks (2014) contends that young people need a space where they can discuss and explore their emotions and learn to appreciate that they are not alone in their concerns. Climate change education can provide a space that allows for concerns and questions to be aired and engaged with constructively (Hicks, 2007).

Resent research suggests young people manage their worries about climate change by either de-emphasising or distancing the issue (Ojala, 2012c). Distancing and de-emphasising of the issue may be the result of students feeling their actions will be ineffective (Ojala, 2012b). In these cases, hope may be fostered through knowledge not only of the issue but of possible courses of action (Schreiner et al., 2005). Ojala (2012c) argues teachers can assist students to regulate their emotions by providing concrete examples of how students themselves may be able to act in pro-environmental ways.

Hope, it has also been argued, must also stem from trust in others and the avoidance of extreme cynicism (Ojala, 2012a). This may be possible through discovering what responses are currently taking place at a national and global scale. Focussing on climate change may lead students to feel bleakness, however emphasising positive thinking, optimism for the future and trust in others may offer a defence from overly negative emotions climate change can create (Ojala, 2012b). It is important climate change education focusses attention to futures and possible pathways to a sustainable future to promote hope in students (Ojala, 2015).

2.3.2.2 Behaviour change for mitigation

Motivating private sphere environmentalism (Stern, 2000) such as reducing personal energy consumption has been the focus of much research and many public climate change communication programs (Wibeck, 2013). Engaging and inspiring individuals to take personal actions in response to climate change are viewed as an imperative by many (Lorenzoni et al., 2007; O'Neill & Nicholson-Cole, 2009; Wolf & Moser, 2011). Maibach, Roser-Renouf, and Leiserowitz (2008, p. 489) for example argue "[t]here is an urgent need to influence people's behavior —on a large scale or population basis—to help prevent and reduce the burden of climate change on human and other populations". Moser (2006) has also argued that through conscious consumer decisions, coordinated collective individual actions can support a systemic change and influence others within the community and act as a political force able to shape policy. However, individual behaviour change has proven to be a complex issue with a number of factors, including knowledge of the issue, knowledge of actions strategies, locus of control, attitudes, verbal commitment and a sense of responsibility (Bamberg & Möser, 2007; Hines, Hungerford, & Tomera, 1987) influencing individual decision making in terms of pro-environmental behaviour (Gifford & Nilsson, 2014; Hines et al., 1987).

While individual actions are an important part of a holistic response to climate change, scholars warn against educational responses that end with simplistic or one-off individual actions (Robottom & Hart, 1995). It has been argued that the promotion of one-off actions in response to climate change can be counterproductive by implying that once an individual has taken such an action the problem is solved and the individual has dispensed their duty (Gonzalez-Guardiano & Meira-Cartea, 2010). Education programs, it is argued, often focus on simple "disarticulated actions" (Gonzalez-Guardiano & Meira-Cartea, 2010, p. 16), such as turning off lights or driving less, while little attention is paid to structural responses. This thinking rests on the belief that climate change, or at least the worst of its impacts, are avoidable through small scale, piecemeal, lifestyle changes and technological or scientific fixes, while maintaining a business as usual approach (Selby, 2010). “Pseudo-solutions” (Kagawa, 2010; Selby, 2010) to climate change do not question the dominant development discourse based on the assumption of limitless economic and material growth (Kagawa, 2010). This focus on individual behaviour change approaches to climate change education is contested by those who argue climate change is a systematic problem and therefore requires climate change education that challenges normative values that shape our worlds (Gonzalez-Guardiano & Meira-Cartea, 2010). Selby (2010, p. 38) argues that it is a “sleepwalked attachment to a distorted value system that is fuelling rampant and runaway climate change” and these attachments need to be critically examined and in this case, individual one-off actions alone do little.

As an alternative, David Selby (2010; Selby & Kagawa, 2010) makes a case for education for sustainable contraction that seeks alternative conceptions of the good life, that moves beyond ‘consumer awareness education’, which implicitly endorses the notion of benign consumerism, to a form of learning that explicitly engages with anti-consumerism education. Selby and Kagawa (2010) argue by offering and considering alternative conceptions of the good life and education in voluntary simplicity, climate change education can offer learners the opportunity to “explore and experience alternatives to a growth economy” (Selby & Kagawa, 2010, p. 43). Climate change education, they argue, should examine the root cause of issues by unpacking and critiquing the “role that the currently hegemonic economic model and social order, allied to voracious consumerism in economically wealthy societies, has played and continues to play in putting the world at risk” (Kagawa & Selby, 2010b, p. 241).

2.3.2.3 Building capacity for adaptation

Preparedness for current and potential consequences of climate change is progressively being recognised as essential. Climate change adaptation education is considered necessary to lower risk and vulnerability and build adaptive capacity and resilience (Krasny & DuBois, 2016; United Nations Educational Scientific and Cultural Organization (UNESCO) & United Nations Environment Programme (UNEP), 2011). Adaptation to climate change has been defined as “the adjustment of a system to moderate the impacts of climate change, to take advantages of new opportunities or to cope with the consequences” (Adger, Huq, Brown, Conway, & Hulme, 2003, p. 192). As such, climate change adaptation education incorporates learning that aims to help individuals to develop the capacity to adapt to changes to their social, economic and ecological environment (UNESCO & INEP, 2011) as well as, reduce vulnerability through disaster risk reduction and preparedness, and emergency education.

As with all climate change education, adaptation education is characterised by uncertainty. The unpredictable nature of climate change requires an approach to learning that is flexible and that builds capacity for responding to specific hazards as well as for reducing general vulnerabilities (Anderson, 2012). Adaptation learning aims to develop capacity and promote resilience by raising awareness and knowledge of local environmental conditions, risks and management strategies (Bangay & Blum, 2010). Learning with a local focus, it is argued, will help individuals recognise potential changes and develop an understanding of the implications of climate change to their daily lives (UNESCO & UNEP, 2011).

Some have argued adaptation education must question the linear, self-limiting ‘project focused’ adaptation rhetoric that emphasises ‘climate proofing’ or the notion that once appropriate measures have been put in place the issue is ‘fixed’ (Tschakert & Dietrich, 2010). Problematically this view “obscures the very processes that shape adaptation and resilient livelihoods” (Tschakert & Dietrich, 2010, p. 2). The complex nature of climate change will mean adaptation is by necessity a “continuous stream of activities, actions, decisions, and attitudes that inform decisions about all aspects of life and that reflect existing social norms and processes” (Nelson, Adgar & Brown, 2007, p.397). In this way adaptation is a dynamic social process that is place specific (Adgar, 2003). In response, adaptation education must be an iterative process, where students develop capacity for anticipatory and participatory learning and learn by doing.

Disaster risk reduction education, an important part of climate adaptation, can build community resilience through a systematic approach to identifying, assessing and reducing risk. Students, teachers and the wider school community can be prepared and empowered to minimise risk associated with disasters and cope with risk during and after a disaster (UNICEF, 2011). It has been argued, at a school wide level, administrative and teaching staff should work to ensure a "climate safe" school environment (UNESCO & UNEP, 2011, p. 61) through 'climate change proofing' educational infrastructure (Bangay & Blum, 2010). Schools should be familiar with local hazards, undertake risk assessments and improve/maintain buildings where appropriate (Bangay & Blum, 2010).

Given that children are particularly vulnerable to the effects of natural disasters, school curricula that incorporate learning about local disaster risks and how to be prepared and cope if disaster strikes can enhance young people's resilience (Back, Cameron, & Tanner, 2009). Supporters of disaster risk reduction education argue students themselves should also be involved with risk reduction processes and be familiar with what to do in the event of an emergency (UNESCO & UNEP, 2011). In a review of the role of education in disaster risk reduction, Wisner (2006), for example, argues for learning that moves beyond knowledge of natural hazards to learning that involves students themselves in exploring their local surroundings, assessing risks and speaking with community members about historical events.

However the reduction of individual and community vulnerability and an increased resilience may require more than practical measures with some arguing it may necessitate a "profound re-thinking of cultural practices and traditions" (Kagawa & Selby, 2013, p. 5). Changes to local climates, and losses of physical spaces as the result of climate change impacts, may have profound "cultural and symbolic impacts" (Adger et al., 2009, p. 347). Many religious and cultural beliefs and practices, for example, are based on seasonal cycles, or attachment to place, and although culture is not static these changes to physical spaces are likely to be rapid and irreversible, and may have profound effects on the ways that individuals and cultures define themselves (Adger et al., 2009).

2.3.2.4 Civic engagement

Climate change is an inherently political issue. Discussions and decision making regarding what can or should be done to mitigate and adapt to the consequences of climate change create clear tensions on varying levels owing to different interests and values. If students are going to act on their knowledge of climate change they will require skills to actively participate within their communities. Scholars claim climate change education should develop a real understanding of political processes, including legislation and approvals (Kagawa & Selby, 2013), while encourging learners to explore possible channels of influence (Schreiner et al., 2005), and how to affect change through grass roots actions like town meetings and petitions (McKeown & Hopkins, 2010).

Further, Schreiner et. al., (2005, p. 41) contend "[g]etting to grips with the climate change problem will require present and future citizens to make ethically founded knowledge based decisions". It has been argued learners must be empowered (Schreiner et al., 2005) to make informed decisions on the best course of action amongst many (Anderson, 2010; McKeown & Hopkins, 2010), requiring the development of the ability to think critically, be open-minded and solve problems (Anderson, 2010). Also integral to informed decision making are communication and interpersonal skills and the ability to work well with expert and community others. These skills are argued as necessary to enable learners to negotiate, work cooperatively and communicate in a meaningful way (Kagawa & Selby, 2013; U.S. Global Change Research Program, 2009).

Other authors argue educational responses should explicitly address conflict avoidance and resolution since climate change has the "potential to exacerbate existing tensions and create new ones" (Bangay & Blum, 2010, p. 360). Climate change is predicted to result in the displacement of large populations of people (IPCC, 2014) and, with these large movements of people, those with limited resources are more likely to migrate in times of hardship (Reuveny, 2007). The consequences are likely to be increased conflicts and tensions which result in local and international security issues. Thus, education about how to understand and work through and within conflict is essential for democracy as well as for safe and healthy communities (Bickmore, 2003).

Globally tensions may also arise due to the inverse relationship between responsibility and vulnerability to impacts (Bangay & Blum, 2010) as historically, the greatest contributors to the enhanced greenhouse problem are industrialised countries, while those countries who are yet or only recently benefiting from development and economic growth fuelled by high carbon energies are most vulnerable. Further, those individuals and communities that are socially, financially or politically marginalised are particularly vulnerable to the impacts of climate change. Within Australia for example, those people who are unemployed, homeless, living in poor accommodation, or frail through age or chronic illness are more vulnerable to the impacts of climate change such as increased food prices, reduced food and water availability, and adverse health effects associated with heat and increased disease risk (Climate Change Authority, 2012). Change education can allow for the exploration of social justice issues locally, regionally and globally. The inequitable distribution of resources, rights and power can be explored allowing students to make connections between their own experiences and that of others.

2.3.2.5 Summary - Climate change education

While Bangay and Blum (2010) acknowledge the importance of key knowledge, they espouse an educational response to climate change that moves beyond additions or new inputs to the curriculum. Rather, they argue, existing educational practices should be examined in line with radically different futures. The question is asked by these authors "in the context of climate change, is the aim of educational programmes to teach people (of all ages) to perform certain 'appropriate' or correct' behavior (e.g. conserving energy, recycling, reducing carbon consumption) or is it to support them to develop the capacities to address rapid change and uncertainty?" (Bangay & Blum, 2010, p. 363). If the goal is to prepare learners for an uncertain future by helping them to gain the capacities (i.e., knowledge, skills, dispositions and values) to deal with future challenges, climate change education must rethink climate change mitigation and adaptation in ways that are not merely technical but socially transformative, using learning approaches that harness creativity and that are empowering (Lotz-Sisitka, 2010).

A clear, coherent educational agenda for climate change education is as yet tentative with several related agendas engaging various aspects of the issue (Anderson, 2010). It has been argued current formal educational responses to climate change have not taken the role of active social learning that advocates personal and societal transformative practice. Rather, climate change education has tended to "mirror the response of society" (Kagawa & Selby, 2010d) at large with curriculum responses focussed on scientific knowledge or the '***climate***' in climate change education and ignoring '***change***', by paying little attention to the consequences of climate change or the need for adaptation to the impact on human settlement and activities (e.g., see Stevenson, 2010). Orr (2004, p.27) argues “we are still educating the young as if there were no planetary emergency”.

2.4 Synthesis of chapter and conceptual framework

The conceptual considerations that guide this research are informed by the above literature, principally the six dimensions of how individuals understand climate change, the influence of teacher beliefs on practice and literature exploring the possibilities of climate change education. Within the ‘understanding climate change’ literature six distinct, nuanced and interconnected dimensions have been identified. These six dimensions are: Awareness; Conceptual understanding; Beliefs; Risk perception; Responses; and Engagement.

Awareness: Various researchers have used the term ‘understand[ing] climate change’ when investigating individual and group awareness of climate change. Leiserowitz (2008) identified awareness as having “heard of” or being familiar with the term global warming or climate change. Leiserowitz (2008) argues awareness of global warming in some regions of the world is low or non-existent, particularly among the Muslim world, acknowledging some people may have “observed, attempted to explain … [or] adapt to changes in their local climate” (p.3) but did not have the exposure to climate change science and the language and theories this would provide. Awareness in this sense is not necessarily having experiences with climate change but being aware that those experiences are related to climate change and that there is a collective scientific knowledge being amassed on the issue.

Conceptual understanding: Weber and Stern (2011) define understanding climate change as “a set of cognitions about what ‘climate’ and ‘climate change’ mean, what the essential attributes of climate are, how these attributes are connected to each other, what causes climate change, what the consequences of climate change will be, and the degree of confidence that should be placed in various knowledge claims about climate change” (p.315). Numerous scholars also define understanding climate change in terms of conceptual understanding, including; acquiring and employing factually correct knowledge of climate change (Wolf & Moser, 2011), knowledge of the physical processes (Bulkeley, 2000) or the mechanisms for climate and how they are connected (Weber & Stern, 2011); knowledge of the causes and

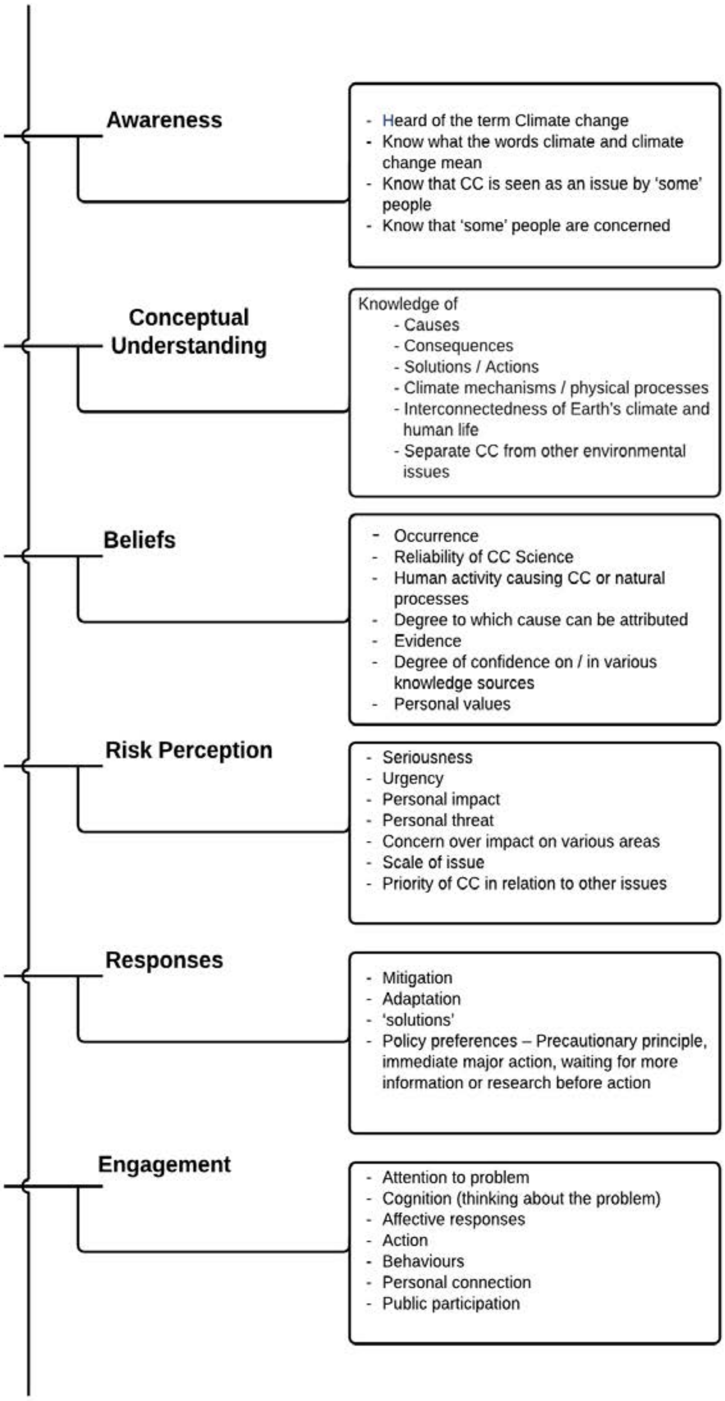


*Figure 2.1: Un*derstanding climate change interpretive framework.

consequences of climate change (Kempton, 1991; Stamm, Clark, & Eblacas, 2000; Weber & Stern, 2011; Whitmarsh, 2009); and potential mitigative or adaptive strategies that may be employed (Papadimitriou, 2004; Stamm et al., 2000).

Beliefs: Alternate to the notion of conceptual understandings or knowledge about climate change, researchers also use the term "understandings" when discussing individual's beliefs relating to the occurrence of climate change, the validity of climate change science, including availability and reliability of evidence, and attribution of cause i.e. anthropogenic, natural or a combination of the two (Leiserowitz, 2008; Papadimitriou, 2004; Whitmarsh, 2009; Wolf & Moser, 2011). Frequently studies are conducted using polls or surveys on large groups of the general public or specific sub groups, for example teachers or university students, to measure beliefs and opinions on climate change occurrence, risks, and causes.

Risk perceptions: Risk perceptions or an individual's assessment of the perceived seriousness of the threat that climate change poses, as well as perceptions relating to the urgency or serious of the threat and personal concern over the threat to oneself and family (Leiserowitz, 2008) are also used as a measurement of understanding within climate change literature. How individuals perceive the seriousness or urgency of the threat climate change poses, as well as the priority individuals place on climate change over other issues is included within this account of understanding.

Responses: Responses to and engagement with are related dimensions, however they are distinct in their usage. Responses to climate change include people's opinions or understandings about appropriate and effective responses to climate change including policy preferences. Understandings of climate change within this usage include an individual's preference for a wait and see approach to action, a need for immediate and major action, or the enactment of the precautionary principle approach to uncertain risk (Leiserowitz, 2008).

Engagement: Engagement within the understanding climate change literature refers to an individual's attention to climate change including active thinking about and interest in the issue, and personal connections. In a paper investigating public understandings about global warming Kempton (1991) describes public understanding as lay people's thinking about the issue. Wibeck (2013, p. 391) identifies and differentiates between two types of public engagement with climate change, the first includes public participation in climate science and political processes, this type of engagement promotes active involvement where individuals feel empowered and are actively involved in decision making. The second type of public engagement involves a more personal connection with climate change, one where the individual cares and feels motivated to act on climate change but does not necessarily involve active participation in policy making (Wibeck, 2013).

Although research on individuals' understandings of climate change is increasingly prolific, research focussed on teachers' understandings of climate change appear to be few. A small number of studies have begun to investigate how teachers' understandings of climate change, particularly knowledge, influence the teaching of climate change within predominantly science classrooms (Monroe et al., 2013; Plutzer, Hannah, et al., 2016; Wise, 2010). This research suggests teachers' understandings of the issue do influence practice, however these understandings require more research. This study moves beyond the knowledge dimension of climate change understanding, recognising that it is more than teacher knowledge alone that influences teacher practices.

This chapter has examined six dimensions of understanding climate change, teachers' beliefs and their influence on practice and the teaching of controversial issues and the emerging educational response to climate change. Finally the chapter outlined the conceptual framework guiding this research. The following chapter will outline this research project's research methodology.

Chapter Three
Methodology

3.0 Introduction

This chapter includes a detailed description and discussion of the research methodology that guided this study. The chapter is organised by several subheadings that provide an outline within which the research methodology and methods are framed. First a statement of purpose is provided, followed by details of the research context. Next the research questions that guided data collection and analysis are presented. A comprehensive research plan is then outlined under the following subheadings: Philosophical assumptions; Research approach; Research participants; Research design; Methods of data collection; Data analysis and synthesis; Ethical considerations; and Limitations of the study.

3.1 Statement of purpose

The purpose of this study was to gain an insight into teachers' understandings about climate change and beliefs about climate change education, and how these affect the implementation of climate change education in Queensland schools. Climate change education presents many challenges to educators. First, climate science is complex, scientific understandings continue to develop and refine over time with potential consequences and implications of a changing climate still quite uncertain. Second, climate change education does not only deal with science but is intertwined with many additional complex social, environmental, political, and economic issues, including economic development and poverty reduction.

The Australian National Curriculum including the Cross Curriculum Priority of Sustainability provides space for teachers to engage with the complexities of climate change (Australian Curriculum Assessment and Reporting Authority (ACARA), 2015a, 2015b). However, as with all curriculum documents, they rely on teachers' own interpretation and priorities and do not, in most cases, encourage teachers directly to engage with climate change as a complex multi-dimensional issue. The understandings, attitudes, motivations and skills of the classroom teacher contribute significantly to the kind of curriculum practices that are enacted. As with most environmental education to date, the success of climate change education programs is reliant on the competence/capacity, dedication, commitment, and enthusiasm of devoted teachers and support from educational policies and leadership. This research sought to identify how teachers' educational and personal beliefs impact on their teaching of climate change.

3.2 Research context - Climate change in the Australian Curriculum

The teachers within this study were, for the most part, teaching the Australian National Curriculum in its early incarnation. The Australian government introduced a national curriculum (Australian Curriculum) in 2012. The Australian Curriculum is developed by the Australian Curriculum, Assessment and Reporting Authority (ACARA) for all Australian states and territories. ACARA is an independent body established by the federal government and funded by all Australian governments with its mission stated as "to improve the learning of all young Australians through world-class school curriculum, assessment and reporting" (Australian Government, 2015, p. 11). Alongside developing the national curriculum, ACARA are also tasked with developing and administering national testing, including collecting, managing and analysing assessment data. ACARA are also responsible for the publishing and reporting of assessment data, which includes the management of the *MySchool* website (ACARA, 2012).

The Australian Curriculum specifies what all Australian students "are to be taught, and the expected quality of learning as they progress though schooling" (ACARA, n.d., para 1). The curriculum includes 8 learning areas which each include a rationale statement explaining its purpose, and an aims statement identifying the major learning that students should demonstrate (ACARA, n.d.). Further, each learning area specifies curriculum to be taught via year level descriptors (see figure 3.1). Supporting each descriptor are elaborations (see figure 3.2) which are described as "optional, and are provided to give teachers ideas about how they might teach the content" (ACARA, 2015).

Additionally, the curriculum describe seven 'general capabilities' and three 'cross-curriculum priorities' (CCP) that apply across all learning areas to be included where appropriate. Each capability and CCP are indicated throughout the curriculum by an identifying symbol (see figure 3.3).

Year 8 Content Descriptions

Science Understanding	*Science as a Human Endeavour*	*Science Inquiry Skills*
Biological sciences	**Nature and development of science**	**Questioning and predicting**
Cells are the basic units of living things; they have specialised structures and functions (ACSSU149)	Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE134)	Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS139)

Figure 3.1. Australian Curriculum – content descriptor

Biological sciences	Elaborations
Cells are the basic units of living things; they have specialised structures and functions (ACSSU149)	• examining a variety of cells using a light microscope, by digital technology or by viewing a simulation • distinguishing plant cells from animal or fungal cells • identifying structures within cells and describing their function • recognising that some organisms consist of a single cell • recognising that cells reproduce via cell division • describing mitosis as cell division for growth and repair

Figure 3.2. Australian Curriculum – descriptors and elaborations

During the time of interviews all Queensland schools were expected to have implemented Phase one (Version 3.0), P-10 learning areas English, Mathematics, Science and History by the end of the current teaching year (Queensland Studies Authority, 2012). Since this study, all other learning areas have been developed and the curriculum has been updated and revised a number of times either through the simplifying or reducing of content in some cases or the increase of content in others (ACARA, 2016). The Australian Curriculum is currently implementing Version 8.1. The term 'climate change' is mentioned in the current (8.1) version of the Australian Curriculum 14 times. The first mention of the term climate change is in Year 6, under the learning area Humanities and Social Sciences (HASS), as an elaboration (see figure 3.4).

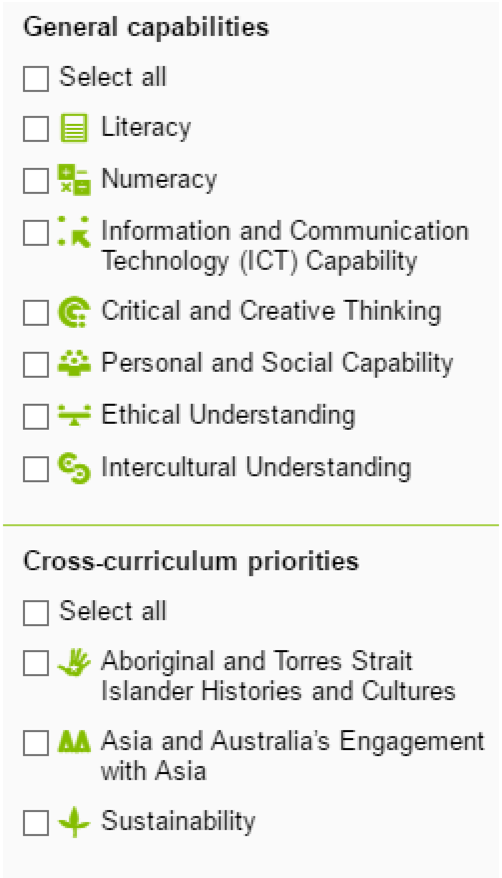
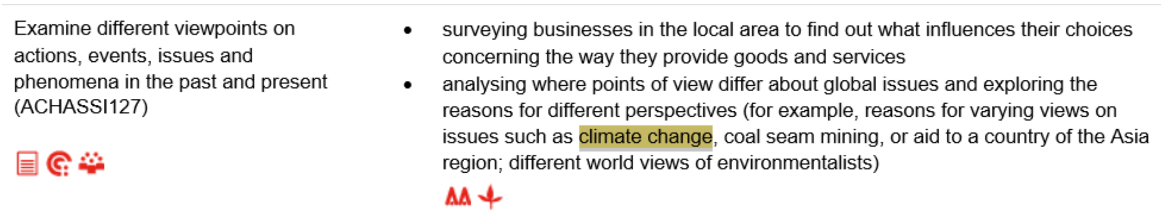


Figure 3.3. General capabilities and Cross-curriculum priorities



Examine different viewpoints on actions, events, issues and phenomena in the past and present (ACHASSI127)	• surveying businesses in the local area to find out what influences their choices concerning the way they provide goods and services • analysing where points of view differ about global issues and exploring the reasons for different perspectives (for example, reasons for varying views on issues such as climate change, coal seam mining, or aid to a country of the Asia region; different world views of environmentalists)

Figure 3.4. Year 6 HASS content descriptor and elaborations

The next mention is in Year 8 History, it is in the context of the decline of an ancient empire. Climate change is mentioned twice as a content descriptor in years 9 (Geography) and 10 (History), and seven times as an elaboration: Year 9 & 10 Media and Arts, year 9 Geography (attached to content descriptor above), year 10 History (attached to the content descriptor above) and Year 10 (Earth and space science x 4) (see Appendix A). Climate change is not mentioned as a content descriptor within Science in any year level.

For a brief overview of the Australian Curriculum (V8.1) in terms of content specific to climate change please see Appendix A. From the above and details outlined in Appendix A, climate change is not a subject the Australian Curriculum places a priority on. Most frequently climate change appears as a suggested 'elaboration' rather than as core content that must be included. When climate change is included in the curriculum, the language used is often tentative and uncertain (Whitehouse, 2013), and often does not provide guidance on how climate change may be approached in terms of the position the curriculum takes on climate change science and anthropogenic influences on climate change, leaving the issue open for wide and varied interpretation.

3.3 Research questions

This research project was framed by an overarching research question and directed by seven sub-questions; three specifically related to teachers' personal beliefs about climate change and four questions to guide the research relating to teachers' professional beliefs about climate change education.

3.3.1 Overarching research question*:*

How do teachers' views on climate change and education influence their teaching of climate change?

3.3.2 Sub questions:

Climate Change

1. How do teachers understand climate change?
2. What are the sources of information teachers use to inform themselves about climate change?
3. What are the personal beliefs of teachers about the causes and consequences of climate change?

Education

4. What does climate change education mean to teachers?
5. What are the beliefs of teachers about the need for and appropriateness of climate change education?
6. What do teachers report as influencing their decision to include or exclude climate change in their curriculum?
7. What do teachers report as their classroom practice in relation to climate change?

3.4 Philosophical assumptions

The way in which we approach research is deeply grounded in what we believe about research and knowledge. Assumptions about reality (ontology) and ways of knowing (epistemology) are commonly framed as a researcher's *paradigm* or *worldview* (Crabtree & Miller, 1999; Creswell, 2014; Creswell & Plano Clark, 2011). These assumptiions have been described as "a general philosophical orientation about the world and the nature of research that a researcher brings to a study" (Creswell, 2014, p. 5). This study has been informed by a critical realist philosophical perspective. Critical realism asserts there is an external world that exists independently of human consciousness, and at the same time there exists our socially constructed knowledge about reality (Danermark, Ekstrom, Jakobsen, & Karlsson, 2002).

Critical realism is based on the ontological realist position – that there is a real world out there independent of human interaction with it, and a constructionist/interpretivist epistemology - all understandings of this real world are constructions, neither scientific nor non-scientific understandings are truly objective or absolute (Crotty, 1998). Critical realism asserts that individuals view empirical 'reality' through their own perceptions and filters, interpreting what they view and constructing an understanding of it, hence knowledge gained cannot be claimed to be a true reflection of what exists, rather, some approximation of it.

3.4.1 Ontology:

Ontology refers to our "[a]ssumptions of the intrinsic nature of reality, of 'what exists' and of the 'essence of things'… [and these] form the foundation for every other assumption we make" (Danermark et al., 2002, p. 18). Critical realists maintain a realist ontological position, asserting "there exists a reality [or real world] independent of our concepts and knowledge of it" (Danermark et al., 2002, p. 20). Reality is both intransitive (exists independently of human conception) and stratified. The ontological stratification of reality is distinguished by Bhaskar (1978) as three overlapping domains; the real, the actual, and the empirical. In general terms the real refers to whatever exists (natural or social) (Sayer, 1999) or intransitive reality. The real exists independently of any interaction or human conception of it and is made up of structures and mechanisms with enduring properties. The actual refers to events that are generated by mechanisms, whether or not they are experienced or observed. Last, the empirical refers to what is actually sensed, observed, or experienced by human consciousness. Within this stratified understanding of reality it can be understood that a reality exists that may or may not be readily observable and that reality is shaped by underlying "powers and mechanisms which we cannot observe" (Danermark et al., 2002, p. 20), how we come to understand this reality is an epistemological question.

3.4.2 Epistemology:

Epistemology refers to our "assumptions of the nature of knowledge, of how we acquire knowledge and of how we 'can know what we know' " (Danermark et al., 2002, p. 18). While critical realism maintains a realist ontology it accepts the social and historical nature of knowledge and acknowledges the world can only be known through available discourses (Sayer, 1999). Knowledge is said to have intransitive and transitive dimensions. The objects we study, including physical processes and social phenomena, form the intransitive dimension (Sayer, 1999), and the transitive dimensions include theories and discourse (Sayer, 1999). It can be said that there may be many different positions on transient objects (theories about the world), however the intransitive dimension (the world) is the same (Sayer, 1999). Reality cannot be observed and documented but rather interpreted, "shaped by the pre-existing theories and world views of the researchers" (Willis, 2007, p. 96).

Importantly, all understandings are constructions, neither scientific nor non-scientific understandings are truly objective or absolute. Critical realism does not assert there is one true interpretation or way of attaining a single fully correct understanding of reality, rather our understanding of the world can never be objective or certain, all theories are grounded in a particular worldview and are fallible (Maxwell & Mittapalli, 2010). However that is not to say that there are no grounds for judging the merits of knowledge claims (Danermark et al., 2002).

All understandings and knowledge, including scientific knowledge, are "constructed … to serve particular purposes" (Crotty, 1998, p. 16) and these purposes, in many cases, have been extremely useful. In other words, there exists a world but not a world of meaning if there is no conscious engagement with it: "the existence of a world without a mind is conceivable. Meaning without a mind is not" (Crotty, 1998, pp. 10-11).

3.4.3 Methodological implications

Examining the causal mechanisms of events, or retroduction underpins critical realism by seeking to explain why things are what they are. Retroduction entails looking beyond lived experiences and/ or empirical observations and looking "back from, below, or behind observed patterns or regularities" (Blaikie, 2004, para 2) in an attempt to discover causal relationships by asking "what must be true in order to make this event possible" (Easton, 2010, p. 123).

Our knowledge of the world cannot be based only on our observations of events, or a flat reality, but rather through the complexity of a stratified ontological understanding over three ontological domains (the empirical, the actual and the real) (Danermark et al., 2002). Critical realists argue we do not have direct access to reality, instead we have access to some aspects of reality through empirical feedback (McEvoy & Richards, 2006) and our knowledge or understandings are "always conceptually mediated and thus more or less truth like" (Danermark et al. 2002, p. 10).

This research is informed by the philosophical underpinnings of critical realism, particularly the notion of ontological realism and epistemological constructionism. Critical realism does not include or exclude any method, however, asserts method should be chosen based on what it is we want to know. Critical realism can account for the ontological realism of climate change while simultaneously recognising the social dimension of knowledge (Cornell & Parker, 2010).

As a researcher I agree that "our perspectives as researchers, the methodologies we choose, and the questions we ask are informed by what we consider salient aspects of our prior knowledge and experience" (Foote & Bartelle, 2011, p. 46). Research is guided by our understandings of the world and as such this research is guided by my own. Within this study I locate myself as an educational researcher informed by my acceptance of the philosophical assumptions outlined above. I hold a Bachelor of Education (Hons I) degree and have a background in teacher education, as both a student and lecturer. As mentioned in chapter one, this research has been undertaken on the understanding that at this present moment in time scientific evidence suggests that the Earth's climate is changing and that humans are the likely cause. Further, the effects of the changing climate will require humans to learn to live differently and with uncertainty. As a mother and a citizen I am concerned about the effect climate change is and will continue to have on the Earth and its people. I believe it necessary for the human race to be fully informed and prepared to make educated, well-reasoned decisions about their own, their family's, their community's and the planet's future. A fundamental component of preparation for climate change is education, within which teachers play a significant role.

3.5 Research approach

An explanatory sequential (quan -> qual) mixed methods research design (Creswell, 2012, 2014; Creswell & Plano Clark, 2011) was used to explore the research questions. Mixed methods research provides for "multiple ways of seeing … hearing" (Greene, 2007, p. 20) and making sense of the social world. Using multiple data collection methods allows researchers to explore complex research problems from different perspectives, and build on the strengths of different methods (Creswell, 2012). The combination of qualitative and quantitative data within this research study enabled the simultaneous exploration of wide trends and a deeper examination of the research questions, allowing for the opportunity to explore a greater diversity of divergent views (Tashakkori & Teddlie, 2003b). The research design, based on complementary assistance (Morgan, 1998), in this instance allowed for a better understanding of the research problem and questions than either methods used in isolation (Creswell, 2011). For example; as there are no previous studies investigating Queensland teachers and their understandings of climate change, a survey offers the opportunity to gather a larger data set in order to begin developing a picture of a wide range of views. However, although the large data set would allow for the identification of views and trends, the survey offers limited opportunity to examine the understandings of any one individual in depth. Conversely, conducting interviews with a select number of participants allows for a deeper exploration of participant views, however, interviews alone would not provide an insight into the beliefs and understandings of a larger cohort.

Mixed methods research has been defined as "research in which a researcher … combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration" (Johnson, Onwuegbuzie, &

Turner, 2007, p. 123). Scholars have used a variety of terms for this approach including mixed methodology, multi-method research, quantitative and qualitative research, combined research, hybrid research and integrated research, however the use of more than one method is most frequently referred to as mixed methods (Creswell & Plano Clark, 2011). Although mixed methods were being used by scholars in the fields of anthropology and sociology in the early 20th Century (Johnson et al., 2007) and Campbell and Fiske advocated for the use of more than one method to improve validation in 1959 (Creswell & Plano Clark, 2011; Johnson et al., 2007), mixed methods research is often touted as emerging in the late 1980s (Tashakkori & Teddlie, 2003).

Mixing methods has brought about considerable debate surrounding the 'incompatibility thesis', based on the notion that quantitative and qualitative data collection methods are underpinned by opposing and irreconcilable ontological and epistemological positions. It was (and likely still is) argued that "[c]ompatibility between quantitative and qualitative methods is impossible due to the incompatibility of the paradigms underlying the methods" (Tashakkori & Teddlie, 2003, p. 7). This idea is based on the notion that methods are tied to paradigms and so when mixing methods, paradigms are also being mixed (Creswell, 2011).

Mixed method research has largely taken a more "positivist methodological orientation, one that employs qualitative data as 'handmaiden' or 'second best' to the quantitative data" (Hesse-Biber, 2010, p. 457), with the overall goal of the qualitative findings being to illustrate or validate quantitative statistical findings (Hesse-Biber, 2010). Typically the explanatory sequential mixed methods design also places priority on the quantitative findings using the subsequent qualitative phase to help explain the quantitative results (Creswell, 2014; Creswell & Plano Clark, 2011). However, this research takes a qualitatively driven approach (Mason, 2006) to mixed methods research. This approach has been called a participant-selection variant by Creswell and Plano Clark (2011). Here qualitatively driven refers to a way of thinking about the research.

There appears to be misunderstandings over the use of the terms qualitative and quantitative as pointed out by Dillon and Wals (2006), with many researchers referring to quantitative data when referencing a questionnaire for example and qualitative data when referring to interviews. This mixed methods study used two methods to collect data, an online survey and one-on-one semi-structured interviews. Both methods collect data that were analysed both quantitatively and qualitatively. The survey data provide the opportunity to develop an overall general understanding of a complex issue not previously investigated with the aim of revealing general themes and trends, as well as, identify participants for phase two. The quantitative data are used to provide a broad overall numerical picture of a wide range of participants as a background or context for the qualitative data. The qualitative data within both the survey and one-on-one interviews provide the "actual words of people in the study, offer many different perspectives on the study topic and provide a complex picture" (Creswell, 2011, p. 535) of the views and motivations of the participants. It is recognised the qualitative data provided insights into participants' "constructed social worlds and into the ways in which they convey those constructions" (Freebody, 2003, p. 137) and may not be "any more authentic or pure a reflection of the self than any other socially organized [sic] set of practices (Atkinson & Silverman, 1997, p. 322 cited Freebody, 2003, p.136).

There is a distinction that is drawn between the notions of generalizability and transferability however both imply the research findings have some form of application beyond the bounds of the actual study (Denscombe, 2009). Transferability "involves the process in which the researcher and readers infer how the findings might relate to other situations" (Denscombe, 2009, p. 189). In this way the findings may not be generalisable however they may be transferable. Researchers and readers may be able to make connections between the findings revealed in this study and a wider context, especially their own.

As mentioned previously, the explanatory sequential (quan->qual) mixed methods design was chosen in this instance as the best means of understanding the research problem. An explanatory mixed methods approach involves two distinct data collection phases, first survey data is collected and analysed with the results used to inform the second phase. The first phase of data collection sought to gather data, via the administration of a survey, from a wide range of participants improving the transferability, if not the generalisability of findings, and to form a general picture of the research problem (Creswell, 2011). The survey data were used to yield information outlining the statistical frequency of trends through closed response questions, as well as, identify themes through open response questions. The second phase of data collection involved one-on-one interviews with participants via telephone. These will be described in more detail in the following sections.

3.6 Detailed research design

The purpose of this research was to examine teachers' understandings of 1) Climate change, including the validity of climate change science, as well as, opinions on the causes of climate change and likelihood and severity of consequences and influences on these perceptions and 2) Climate change education, including beliefs relating to the necessity or appropriateness of climate change as an educational focus, and how these beliefs influence teacher planning and decisions. With these goals as a guide, an explanatory sequential (quan → qual) mixed methods research design (Creswell, 2012; Creswell & Plano Clark, 2011) was employed. An overview of the research design is illustrated in Figure 3.5.

3.6.1 Methods of data collection

The multiple methods approach allowed for an exploration of an overall wide-view or bigger picture of the understandings, beliefs and practices of Queensland teachers, as well as, providing the opportunity to explore in depth influences on teacher beliefs and practices. As such complementary methods were chosen and data collection was conducted in two distinct phases. The first phase of the study involved the administration of an online survey, the second phase involved one-on-one interviews.

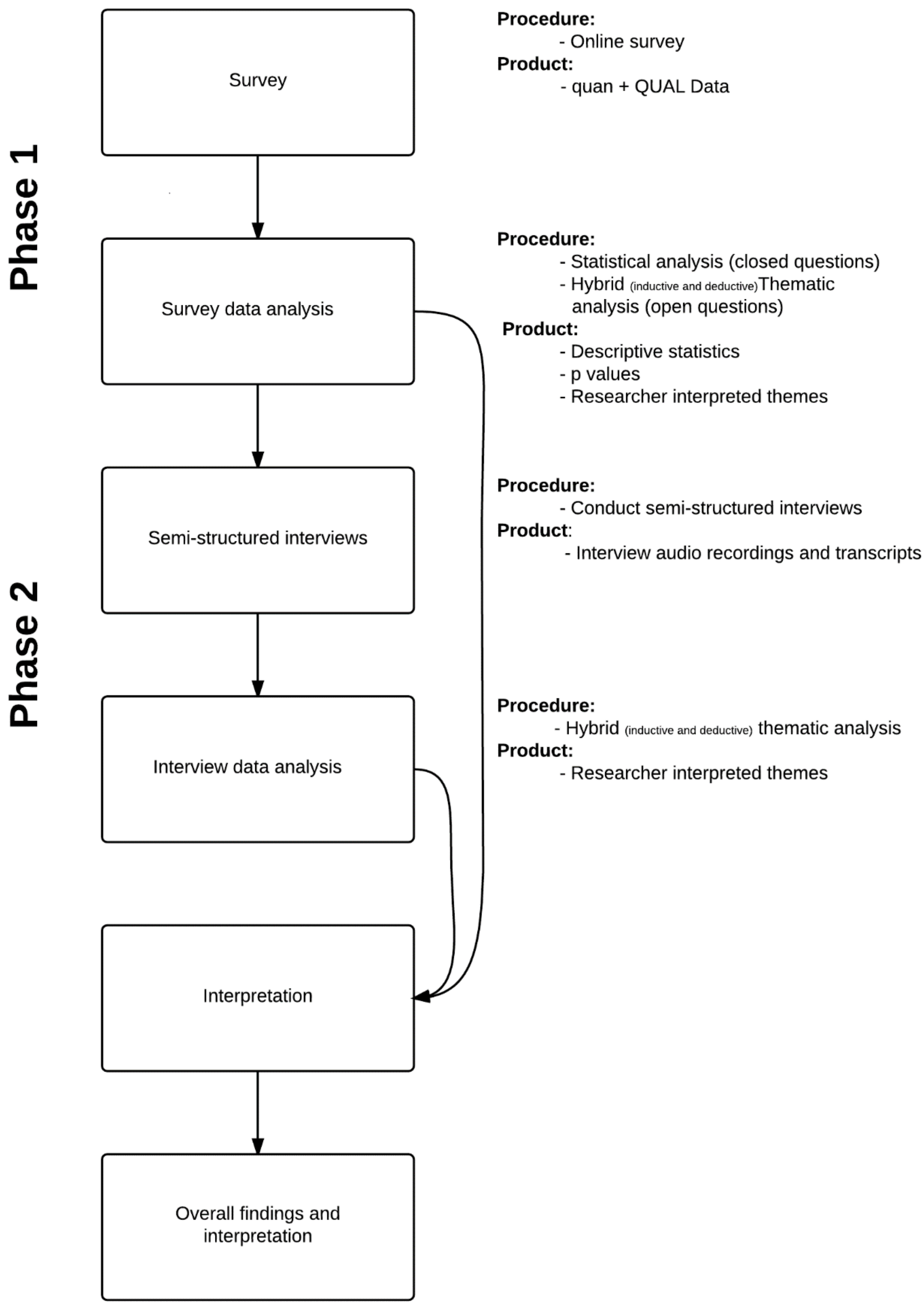


Figure 3.5. Mixed methods research design

3.6.1.1 Online survey (Phase 1)

The first phase of this study employed an online survey utilising a list based sampling frame (Fricker, 2008) hosted on SurveyMonkey. The purpose of the survey was to collect data from a large population in order to 1) begin to develop an understanding of the views of teachers in Queensland and 2) identify possible participants for phase two.

The survey was hosted online as a means of reaching a larger number of teachers, reducing the time and costs associated with traditional paper surveys (i.e. printing, posting and entering data), and also to add an additional sense of privacy for the participants (Fricker, 2008). As the subject of the survey involves teacher beliefs about a controversial issue, it was hoped the use of an online survey, where respondents could remain completely anonymous, would allow for the contribution of richer and uncensored responses (Vehovar & Manfreda, 2008).

The survey consisted of 28 questions including eight demographic questions, 10 questions relating to personal beliefs and perceptions about climate change and eight questions relating to professional beliefs and perceptions about climate change education (see Appendix B). Many of these questions included multiple related sub questions. Two further questions allowed for respondents to supply additional information they felt necessary and provide contact details for follow-up interviews. The survey questions addressing climate change were selected and taken verbatim from Reser et al.'s (2012) study which employed a survey instrument to investigate risk perceptions, understandings, and responses to climate change in Australia and Great Britain. The survey items for this study were selected from Reser et al.'s larger survey based on their relevance to the current study's overarching research questions and aims. Their study provided an important data set with which to compare and contrast survey findings. The 10 climate change education questions were modelled (structure and wording) on the questions relating to climate change and guided by the overarching research questions and aims.

The survey was developed in consultation with experienced education researchers and was tested for reliability through a pilot phase. Initial surveys were piloted through distribution to a small number of local university, primary, and high school teachers for completion and comment. The survey was modified based on the pilot group feedback prior to being finalised and placed on online.

Initially it was the intention that the survey would be administered within schools located in the Far North Region of Queensland. All state school principals within the region identified via the Department's website (121 schools) were contacted seeking permission for teachers to take part in the research project. The response rate to this email request was low. Of the 121 school principals contacted within the Far North Region, only eight responded. Of those, two indicated they would be happy for their staff to take part in the research project and six declined.

As the response rate was low and deemed insufficient for the purposes of the research project a second option was enacted. The survey was made available to all Queensland State School teachers. The researcher considered various methods of informing teachers about the survey. Initially snowball sampling (Morgan, 2008) was trialled as a method of recruiting respondents, however, very few people contacted answered the survey (n= 3). Subsequently advertisement of the survey within the Queensland College of Teachers e-newsletter (QCT e-News) was trialled. QCT e-News is an email news bulletin sent bi-monthly to all teachers for whom the QCT holds an up-to-date email address: "[t]he purpose of the e-News is to advise teachers of recent publications from the QCT and to update them on QCT activities and matters concerning their teacher registration" (Queensland College of Teachers, 2014).

A notice was placed within the QCT E-news in the October, 2012 and August, 2013 editions (see Appendix C). The notice informed teachers of the purpose of the survey and responses were sought from a range of viewpoints. At the time the survey notice was advertised, the bulletin was sent to approximately 99,000 email addresses (I. Bartlett, personal communication, February 20, 2014). At total of 377 surveys were collected via survey monkey between July 2012 and December 2013. Peak survey completion times were directly after advertisement in the QCT e-News bulletin in October 2012 (210 respondents) and August 2013 (124 respondents). It is not possible to know the response rate due to the nature of the method used. Although there is the potential for all people on the email list to have received the email, it is extremely unlikely. QCT did not have the information available to report on the number of emails returned or otherwise. Further, it is also not possible to know how many people opened the email, read the newsletter or saw the advertisement.

3.6.1.2 Semi structured teacher interview (Phase 2).

The second phase of this research study involved semi-structured interviews with 21 teachers from various locations within Queensland. The final question on the online survey informed respondents that the researcher was interested in conducting follow-up interviews with teachers to elaborate on and clarify ideas covered within the survey. Teachers who were interested and happy to participate in follow-up interviews were invited to leave their name and a point of contact. Twenty four teachers' responded to this call, all leaving a name and email address for contact. The respondents were contacted individually via email to schedule a suitable time for a telephone interview convenient to the participants. Of the 24 replies 21 interviews were scheduled. Telephone interviews were conducted due to the large geographical distribution of participants.

3.6.1.3 Interview schedule design.

The interview questions were informed by the research questions and responses to the online survey. Semi-structured interviews allow for the respondent to answer questions more freely or openly (Hayes, 2000) and are designed to allow for the participants to express their understandings and ways of making meaning. The semi-structured interviews enhance interpretation of, and build upon, the data from phase one. The semi – structured interview schedule consisted of a number of questions to guide the interview allowing the researcher to follow-up on any relevant comments (Lankshear & Knobel, 2004) or allow for the interview participant to elaborate on points they deemed important or relevant (Freebody, 2003). Most questions were designed to be relatively open ended to allow participants to elaborate on their views and opinions (Lankshear & Knobel, 2004). Several pilot interviews were conducted as the interview schedule was refined before phase two commenced (see Appendix D for final schedule). The same interview schedule was used for each interview to help ensure consistency, however, the schedule was not followed uniformly in each interview. In some cases respondents elaborated on one question, effectively answering others, at other times further clarification was sought. In all cases the order of the questions depended on the overall progress of the interview, in this way each interview was tailored to the interviewee.

3.6.1.4 Conducting interviews

As mentioned, due to the large geographical range of interview participants, interviews were conducted via telephone. As the topic of the interview was controversial to many, it was important for participants to know that they or their school would not be identified in any way, and that the interviewer was interested in and valued all opinions and responses. The researcher first obtained verbal consent for the interview to be recorded and data to be used in a doctoral thesis and other future publications. Second, each interview began with a small number of easily answered questions not directly related to the research study in order to help put the interviewees at ease (Lankshear & Knobel, 2004). The interviews were then separated into two sections as with the surveys. The first section was focused on participants' personal understandings relating to climate change and the second section focussed on participants' professional beliefs about climate change education. This separation was made clear to the interviewees prior to asking any questions specifically relating to the study.

The telephone interviews typically lasted 45 to 60 minutes. The interview recordings were transcribed by the primary researcher in the days after each interview. The interviews yielded 218 pages of transcript data.

3.7 The research participants

The research participant population was identified as teachers registered with the Queensland College of Teachers, teaching across all year levels from early childhood to Year 12. All school teachers within Queensland schools are required to be registered with the Queensland College of Teachers [QCT] (Queensland College of Teachers, 2015). In 2014, a total of 100,214 teachers were approved and registered with the QCT (I. Bartlett, personal communication, February 20, 2014). Of these, 60,353 were teaching in a Queensland school and 39,861 were registered but not teaching in a Queensland school (I. Bartlett, personal communication, February 20, 2014). Further, 44,754 were female, 15,599 were male with the average age of all teachers being 44.3 years old (I. Bartlett, personal communication, February 20, 2014).

3.7.1 Survey respondents

A total of 377 surveys were collected via survey monkey between July 2012 and December 2013. Of the 377 individual responses to the online survey 48 were discarded due to incomplete responses or other collection errors. In total, 329 teachers submitted complete and usable responses to the online survey. Of these 66% (216) identified as female, 34% (111) identified as male, and two respondents chose not to answer to this question.

The majority of respondents were between the ages of 45 to 54 (29.4%) and 55 to 64 (30.4%) years old. With six respondents identifying as being less than 24 years old (2%) and 12 as being over 65 years old (3.9%) see Figure 3.6.

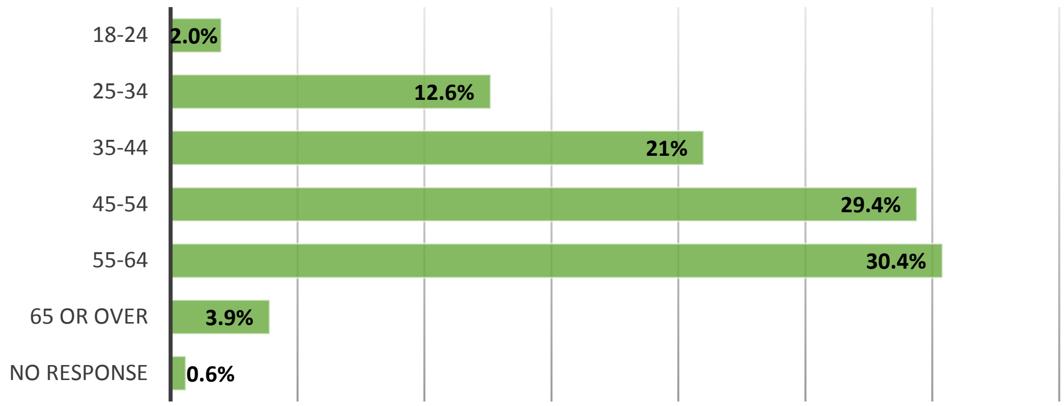


Figure 3.6. Age of respondents

Forty seven percent of respondents (144) identified a Bachelor's Degree as the highest level of education attained at the time of the survey as shown in Figure 3.7. Further, Figure 3.8 details the number of years teaching experience respondents identified as holding, with the majority of respondents (165) identifying as holding over 15 years teaching experience.

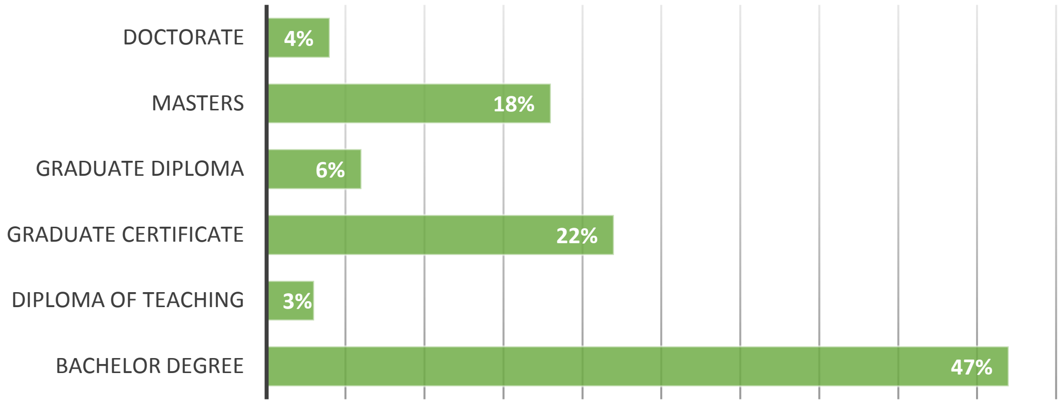


Figure 3.7. Level of education

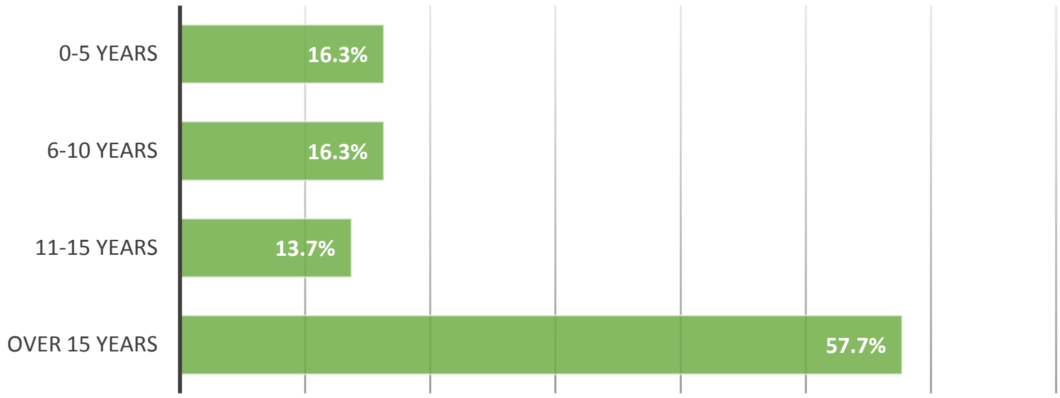


Figure 3.8. Number of years teaching experience

The majority of respondents worked in schools within the South East Queensland Region as shown in Figure 3.9. As many of the respondents within this region did not clearly differentiate between the South East, Metropolitan and North Coast regions, all respondents who answered this question with phrases including Brisbane, Gold Coast, South East, North Coast, Metropolitan, and SEQ were grouped together within the region of South East Queensland which, for the purposes of this study, includes the 3 regions of South East, Metropolitan, and North Coast (see Appendix E for details of Queensland school regional structure as defined by The State of Queensland, Department of Education, Training and Employment).

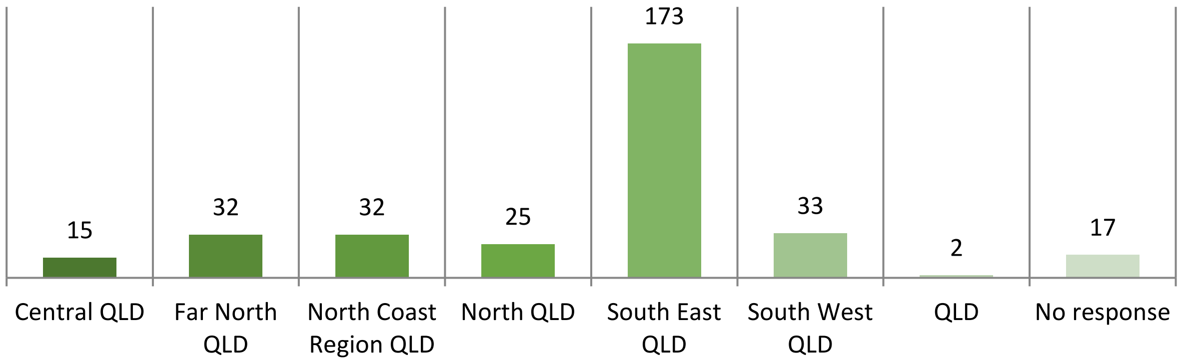


Figure 3.9. Queensland school region respondents worked within

The proportion of teachers who responded to the survey teaching in primary, secondary, and tertiary sectors are described in Table 3.1 and the subjects currently being taught are noted in Figure 3.10. Science teachers made up the greatest number of respondents, including general science teachers and specific disciplines such as chemistry and physics. A number of teachers reported teaching more than one subject. In these instances all subjects listed were tallied as written, for example, one teacher may have answered primary teacher and another junior primary. In this instance each would have been coded under the relevant term. Science teachers who did not specify a discipline were coded under science while those that specified, for example biology and chemistry, were coded under both biology and chemistry and not under science in general. Due to this method of coding responses, it will be noted the total number is greater than 329 in total.

Table 3.1

Year Level currently teaching

	Total number	Percent (%)
Primary	136	41.3
Secondary	154	46.8
P-12	21	6.4
Tertiary	14	4.3
Administration	3	0.9

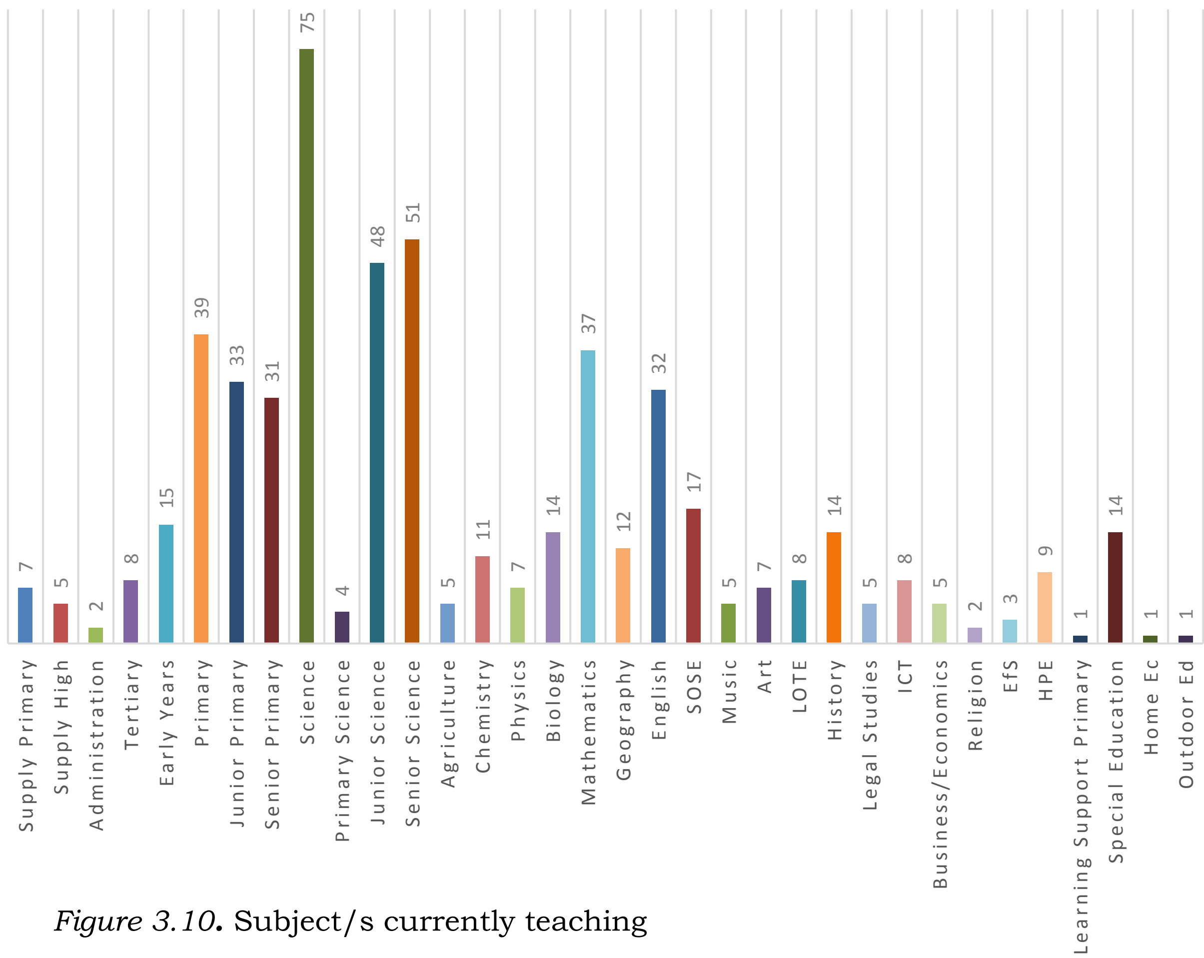


Figure 3.10. Subject/s currently teaching

3.7.2 Interview participants

Of the 21 teachers interviewed 10 were female and 11 were male. The teacher participants included 10 science teachers, six primary teachers, one high school mathematics teacher, one high school LOTE (languages other than English) teacher, two teachers working in the tertiary sector and one teacher working as a science curriculum advisor. Each participant has been assigned an identifier to allow for easy identification of relevant demographic information. These identifiers are used throughout the remaining chapters. The identifier and further details of each participant can be found in Table 3.1.

3.8 Data analysis and synthesis

This section will outline the data analysis undertaken within this study. The data set consisted of qualitative and quantitative data from the online survey and transcribed semi-structured interviews.

3.8.1 Survey data

Survey data relating to participant demographics and responses to the closed answer and Likert-type questions were analysed with qualitative data analysis software Nvivo10 and IBM SPSS Statistics 22 statistical analysis software. These analyses provided frequency distribution which served to organise and summarise the data (Kalaian, 2008). Additionally a small number of statistical analysis were conducted to look for significant differences in results including one-way analysis of variance (ANOVA) and one sample t-tests. The closed-questions made up a total of 23 of the 28 questions asked. Open-ended questions were analysed primarily guided by the research questions and the interpretive frameworks of understanding climate change and climate change education. These frameworks were used as a guide for overarching conceptual categories within which sub-concepts or themes would be organised, a detailed description of this process is outlined below in section 3.9.2. Coding of the open-ended questions was completed with the aid of NVivo10. The open-ended questions included three questions relating to climate change education, one question allowing for additional comments or information and one question relating to follow-up interviews.

Table 3.2.

Interview participant demographic information

Name Identifier[a]	Subject/ Year level	Summary
Jeanette F, 55-64, S, H1	Science/ Jnr secondary	Jeanette feels she knows a fair amount about climate change, tends to agree the climate is changing and that there are risks to Australian people from climate change. When asked to state a position on climate change causes Jeanette selected – climate change is partly caused by natural processes and partly caused by human activity. Jeanette stated climate change education is a priority for her.
Jamie M, 55-64, S, P-H1	Science/ P-12	Jamie feels he knows a lot about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change causes Jamie selected – climate change is mainly caused by human activities. Jamie stated that climate change education is a high priority for him.
Paul M, 55-64, S, H1	Science/ Secondary	Paul feels he knows a lot about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change causes Paul selected – climate change is caused entirely by human activities. Paul stated climate change education is a priority for him.
Kristy F, 35-44, NS, P1	Snr Primary	Kristy feels she knows a little about climate change, tends to agree the climate is changing and neither agrees nor disagrees that climate change poses risks to Australians. When asked to state a position on climate change Kristy selected – climate change is partly caused by natural processes and partly caused by human activities. Kristy stated climate change education was a priority for her.

Samantha F, 25-34, NS, P2	Snr Primary	Samantha feels she knows a fair amount about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change causes Samantha selected – climate change is mainly caused by human activities. Samantha stated that climate change education is a high priority for her.
Chris M, 35-44, S, H2	Science/ Secondary	Chris feels he knows a lot about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change causes Chris selected – climate change is caused entirely by human activities. Chris stated that climate change education is a high priority for him.
Mike M, 45-54, S, H3	Science/ Secondary	Mike feels he knows a lot about climate change, is certain the climate is changing but strongly disagrees that there are risks to Australians from the changing climate. When asked to state a position on climate change Mike selected –climate change is entirely caused by natural processes. Mark stated climate change education is a high priority for him.
Phil M,45-54, S, H4	Science/ Secondary	Phil feels he knows a lot about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change Phil selected – climate change is partly caused by natural processes and partly caused by human activities. Phil stated climate change education was a priority for him.
Susie F, 65+, NS, T1	English/ Tertiary	Susie feels she knows a little about climate change, is certain the climate is changing and tends to agree that climate change poses risks to Australians. When asked to state a position on climate change Susie selected – climate change is partly caused by natural processes and partly caused by human activities. Susie stated climate change education was a priority for her.

Neil M, 55-64, NS, H1	Mathematics/ Secondary	Neil feels he knows almost nothing about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change Neil selected - climate change is partly caused by natural processes and partly caused by human activities. Neil stated climate change education is a high priority for him.
Ellen F, 35-44, NS, H1	LOTE/ Secondary	Ellen feels she knows a little about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change Ellen selected - climate change is partly caused by natural processes and partly caused by human activities. Ellen stated climate change education is a high priority for her.
George M, 45-54, NS, P1	Primary	George feels he knows a little about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change George selected - climate change is partly caused by natural processes and partly caused by human activities. George stated climate change education is a high priority for him.
Daisy F, 55-64, S, H2	Science/ Secondary	Daisy feels she knows a lot about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change Daisy selected – climate change is partly caused by natural processes and partly caused by human activities. Daisy stated climate change education is a high priority for her.
Julianne F, 55-64, S, H3	Science/ Secondary	Julianne feels she knows a little about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change Julianne selected – climate change is mainly caused by human activities. Julianne stated climate change education is a high priority for her.

Catherine F, 55-64, NS, P3	Primary	Catherine feels she knows a little about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change Catherine selected – climate change is partly caused by natural processes and partly caused by human activities. Catherine stated climate change education is a high priority for her.
Bob M, 55-64, S, H5	Science/ Secondary	Bob feels he knows a fair amount about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change causes Bob selected – climate change is mainly caused by human activities. Bob stated climate change education is a priority for him.
Jasmine F, 45-54, S, H4	Science/ Secondary	Jasmine feels she knows a lot about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change causes Jasmine selected – climate change is mainly caused by human activities. Jasmine stated climate change education is a high priority for her.
Dennis M, 45-54, S, H6	Science/ Secondary	Dennis feels he knows a fair amount about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change causes Dennis selected – climate change is mainly caused by human activities. Dennis stated climate change education is a priority for him.
Fiona F, 45-54, NS, T2	Business/ Tertiary	Fiona feels she knows a fair amount about climate change, is certain the climate is changing and that climate change poses risks to Australians. When asked to state a position on climate change causes Fiona selected – climate change is mainly caused by human activities. Fiona stated climate change education is a high priority for her.

Ray M, 35-44, NS, P2	Primary	Ray feels he knows a little about climate change, tends to agree that the climate is changing and that climate change poses a risk to Australians. When asked to state a position on climate change Ray selected – climate change is mainly caused by natural processes. Ray stated climate change education is neither a high or low priority for him.
Raoul M, 55-64, NS, P3	Primary	Raoul feels he knows a fair amount about climate change, he strongly disagrees with the statements "I am certain climate change is really happening" and "There are risks to people in Australia from climate change". When asked to state a position on climate change Raoul selected - climate change is mainly caused by natural processes. Raoul did not indicate whether climate change education was or was not a priority for him.

Note. [a] Identifier. Gender = (F) Female, (M) Male; Age = 25-34, 35-44, 45-54, 55-64, 65+ (over); teaching specialty (S) Science (NS) non science; Year level = (P) Primary (Prep to Year 7), (H) Secondary (Year 8 to Year12) (High school), (T) Tertiary; individual identifying number.

3.8.2 Interview data

Interview data were thematically coded and analysed using a hybrid approach (Fereday & Muir-Cochrane, 2008) incorporating both a deductive, a priori template approach (Crabtree & Miller, 1999) and an inductive data driven approach (Braun & Clarke, 2006). This analysis approach allowed for a focussed encoding of data while allowing for new themes or codes to emerge directly from the data. The template approach begins by the researcher defining or creating a coding scheme or template, in this instance based on the framework described in chapter two and the research questions. This template provides a means of maximising coherence amongst codes in a large data set (Creswell, 2014), as well as, a method of organising text for subsequent interpretation (Crabtree & Miller, 1999). In addition to the a priori template approach, an inductive approach or bottom up thematic analysis (Braun & Clarke, 2006) was used to code all data "without trying to fit it into a pre-existing coding frame" (Braun & Clarke, 2006, p. 12).

The semi-structured interview responses were transcribed verbatim by the researcher over a number of weeks. This process allowed for the researcher to re-familiarise herself with the data and begin to form some preliminary ideas around potential thematic codes. Poor data was flagged (Guest, MacQueen, & Namey, 2012) to help reduce data and returned to after coding to ensure it did not contain any useful information. After transcription was complete the word files were uploaded to QSR NVivo 10 qualitative data management software package installed on the researcher's computer where data coding was undertaken. This process is described below (also see Figure 3.11).

3.8.2.1 Qualitative analysis

1. Development of coding template/scheme.

A coding template or coding scheme is used to help organise related or similar text for interpretation (Crabtree & Miller, 1999). The a priori coding schemes used within this project were developed a priori with the aid of literature and the research questions. Two separate coding schemes were developed. One focussing on understanding climate change and the second on climate change education.

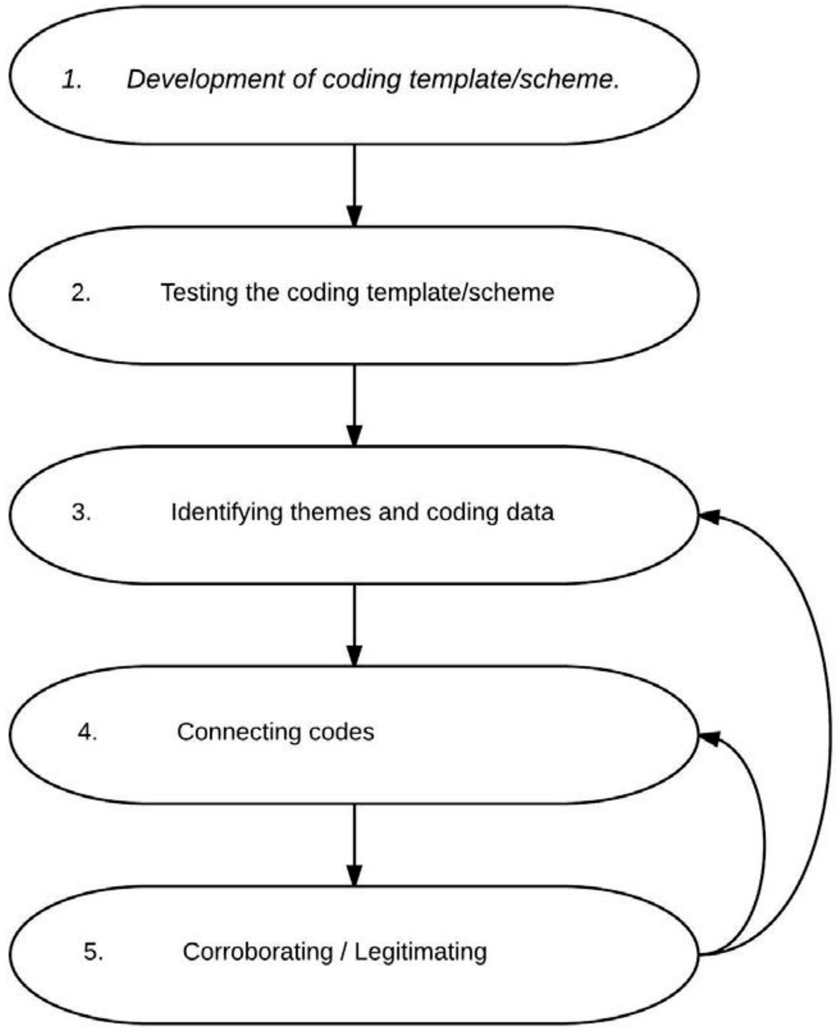


Figure 3.11. Stages of data coding and analysis (adapted from Crabtree & Miller, 1999; Creswell, 2014*)*.

2. Testing the coding template/scheme

Crabtree and Miller (1999) suggest individual members of a research team independently code a number of pages of text to test for reliability and appropriateness of codes. In this instance the coding schemes were trialled on two separate texts respectively by the researcher, additionally two independent researchers were invited to code the same texts using the coding schemes. The results were compared to ensure reliability and differences were discussed. This process resulted in changes to some codes.

3. Identifying themes and coding data

The coding scheme subheadings were entered into NVivo10 as nodes (thematic codes). Under each node, sub-nodes can be added as a means of affording greater specificity. Principally coding took place over two stages. During the first stage analysis concentrated on participants' personal understandings about climate change. The second stage concentrated analysis on participants' professional beliefs about climate change education. Within each of these principal stages focussed coding of complete responses took place over a number of periods corresponding with the research question foci. Analysis was guided by the coding scheme however was not limited by it. During coding new nodes were added when text was not adequately represented by the developed scheme.

4. Connecting codes

Connecting codes involves examining the coded data or "meaningful segments" (Crabtree & Miller, 1999, p. 170) to identify relationships and complex theme connections (Creswell, 2014). The process entails a progression from the organisation of data into patterns to interpretation where there is an attempt to "theorise the significance of the patterns" (Braun & Clarke, 2006, p. 13) and their broader meanings and implications in relation to the literature (Braun & Clarke, 2006), including how findings either confirm or diverge from previous literature and or theories (Creswell, 2014). This process took place within and across both data sets (i.e. survey and interviews).

5. Corroborating/Legitimating phase

Fabricating, discounting, and misinterpreting evidence are all possible unintentional errors that may occur during interpretation (Crabtree & Miller, 1999). During this final stage all previous stages were re-examined for consistency. Un-coded text were analysed for potential new interpretations (Crabtree & Miller, 1999) and whole texts re-read to ensure interpretations reflected original meanings. In addition to this throughout the coding process, random text samples were reviewed by a person outside of the project and cross checked, irregularities were discussed and adjustments made where necessary.

Additionally, coding were cross-checked on a number of occasions with thesis advisors/supervisors to ensure coding agreement.

3.9 Ethical considerations

This research project was approved by the James Cook University Human Research Ethics Committee on 14 December, 2011 and was allocated ethics approval number H4434 (see Appendix F). The research was deemed to be Category One, or low risk.

The primary ethical concern related to participant confidentiality, and all reasonable steps were taken to ensure personal information was protected. All research and management of data were in line with James Cook University's (2015) *Code for the responsible conduct of research* guidelines, data management and storage policy. All data were stored on a password protected hard drive and securely stored at all times. The survey was hosted online via SurveyMonkey which respondents accessed via a URL. Once the survey collection period had ended data were downloaded from this site and saved as an .xls file. All respondent data were anonymous excluding those participants who agreed to be contacted for follow up interviews. These respondents' data were saved as a separate file in order to make contact and identification of data easier. Survey respondent data were loaded onto NVivo 10 (qualitative data analysis software) and IBM SPSS Statistics 22 located on the researcher's university computer.

Interview recordings were downloaded to a password protected hard drive at the completion of each interview and deleted from the recording device. Interview transcripts were saved to a password protected hard drive and loaded onto NVivo 10 on the researcher's university computer. All data used within NVivo 10 were de-identified and assigned identifiers.

3.10 Limitations of the study

This study was designed to gain an insight into teachers' beliefs about climate change and education. A limitation of this study is the reliance on voluntary participation in the survey interviews potentially introduces a selection bias (Olsen, 2008). Voluntary participation in both the survey and interviews, may have resulted in a biased sample in which those interested in the topic were more likely to respond to the call (Sterba & Foster, 2008). Due to this limitation generalising the findings beyond the sample population is problematic. Despite this possible bias, the survey results did indicate a wide spread of teacher participants holding various viewpoints on the issues explored, given that on most survey items the full range of choices were selected. Additionally, the survey sample was broadly in line with a recent Australian sample (Reser, Bradley, Glendon, Ellul, & Callaghan, 2012) in key areas relating to positions held by individuals on the reality and causes of climate change indicating the survey sample within this study was not dissimilar to larger representative samples. Therefore, the survey sample likely reflects the full range of Queensland teachers' perspectives, if not representative in numbers.

An additional limitation of this study was the absence of classroom observational data and student voices. The inclusion of classroom observations and student voices would have made a significant contribution to this study. This study relies on self-reported practices, and teacher interpretations of student interest and opinions. Unfortunately, classroom observation and further research seeking to include student voices was not feasible due to the limited time and resources available.

While acknowledging these limitations, this study provides important insights into what teachers believe and understand about climate change and education, and how these beliefs influence their teaching practice. The use of multiple methods to collect and analyse data meant a richness of data from which to begin to explore key trends in teachers' thinking about a complex and highly relevant social issue.

3.11 Chapter summary

This chapter has provided an overview of the research approach and design used within this study. Chapter four and chapter five will present the findings of both the surveys and interviews. Findings are organised over the two chapters. The first, Chapter 4 Climate change, will outline findings relating specifically to teachers ideas, beliefs and conceptions about climate change and second, Chapter 5 Climate change education, will present results from questions specifically focused on teachers' beliefs, understandings and conceptions of climate change education.

Chapter Four
Research Findings & Analysis
Climate Change

4.0 Introduction

This chapter and the following chapter five report the findings from the online survey made available to registered teachers in Queensland, Australia and interviews with 21 teachers. Chapter four contains findings relating to questions specifically focussed on teachers' understandings of climate change, while findings related to teachers' beliefs about climate change education can be found in chapter five.

The survey findings present an extensive picture of the respondents and provide a setting which helps frame and contextualise interview questions, as well as, provide breadth to the interview data analysis. This chapter is organised around subheadings related to the first set of research sub-questions: (1) How do teachers understand climate change? (2) What are the sources of information teachers use to inform themselves about climate change? and (3) What are the personal beliefs of teachers about the causes and consequences of climate change?

4.1 How do teachers understand climate change?

How individuals understand climate change is multifaceted. This research explored teachers' understandings of climate change through six dimensions, identified and described in chapter two. These are: awareness, knowledge, beliefs, risk perceptions, responses and engagement. This section will present data relating to teachers' understandings of climate change within each of these six categories/dimensions.

4.1.1 Awareness

Awareness of climate change or having heard about the issue, including awareness of the causes and consequences, are key components of an individual's understanding of climate change (see chapter two). To explore teachers' awareness of climate change each interview began by asking participants to outline what they think of when they hear the term 'climate change'. Participants were not given any context for their response and were free to interpret the question and provide their response based on their own assumptions. All teacher participants were familiar with the term and included in their response a reference to changes in the Earth's climate. Changes in climate were most frequently positioned within a current context and mostly included a reference to temperature changes:

> *Climate change is the pattern of, well basically it's just the changing climate that we are experiencing in these recent times. So yeah, climate is climate basically, but it is in the process of changing [F, 35-44, NS, P1].*

> *Well basically climate change means prolonged trends in change of temperatures, in the weather patterns that we have occurring [M, 55-64, S, H5].*

The participants also referenced anthropogenic influences on climate while recognising historical changes in climate. Some explicitly acknowledged their thinking about climate change, at this time, is particularly related to human impacts on climate:

> *Um well I'd put anthropogenic in front of it actually. I mean climate changes and climatic changes like the ice ages have gone on forever. But what I understand to be climate change in the current context is sort of extraordinarily rapid change being caused by human influences to the environment. Basically heating up mostly... [M, 55-64, S, H1].*

Others more cautiously:

> *Well climate change to me means the planet's climate changing. Whilst we know it has changed over history ah, you know geological times, climate change to me specifically refers to the possibility that human activity on the planet is actually adding to that natural cycle, and is actually changing the*

climate in a way that is perhaps in addition to any natural change [M, 55-64, NS, H1].

Climate change in the current context I think of the human impact on the climate but I also think of the longer term view going back through the geological records and the fact that the climate and the atmosphere on earth has changed over millions of years [F, 55-64, S, H3].

Consequences of climate change were also mentioned by a number of participants within their responses to the beginning question. Although no one response referred to immediate, local, or personal impacts of climate change, vague references were made to the idea that a changing climate may have some impacts:

I think it means changes in temperature and basically that the world is getting warmer and um, I think immediately of the polar ice caps and things like that melting and the bears basically [F, 65+, NS, T1].

It's current but keeping in mind this isn't something that just happened yesterday. It's moving and we're at the pointy [end], now we are seeing things happening around the world that we are not used to and that you get the sense that certainly in the future things are going to get worse. Worse in terms of maybe the world's going to get even warmer and the seas might rise [M, 35-44, NS, P2].

This result was not unexpected as most adults in developed countries, including Australia, are aware of climate change and feel they know at least something about the topic (Pelham, 2009; Pugliese & Ray, 2009; Reser et al., 2012).

4.1.2 Knowledge

Moving beyond awareness or recognition of the issue, how an individual understands climate change begins to take a more complex character.

Conceptual understandings, or knowledge about the causes, consequences and/or potential mitigation and adaptation strategies, are frequently measured and viewed as an important factor when attempting to explore individuals' understandings of climate change (Reser, Bradley, Glendon, Ellul, & Callaghan, 2012). Survey respondents were asked how knowledgeable they felt they were about climate change. Respondents selected from a six point scale, one (1) indicating participants felt they knew a lot about climate change to six (6) indicating participants felt they knew nothing (see Figure 4.1). Forty-nine percent of respondents felt they knew a fair amount about climate change positioning themselves at either one (1 = a lot) or two (2) on the scale. Very few respondents believed they know little (5, 5%) or nothing (6, 0%) about climate change**.**

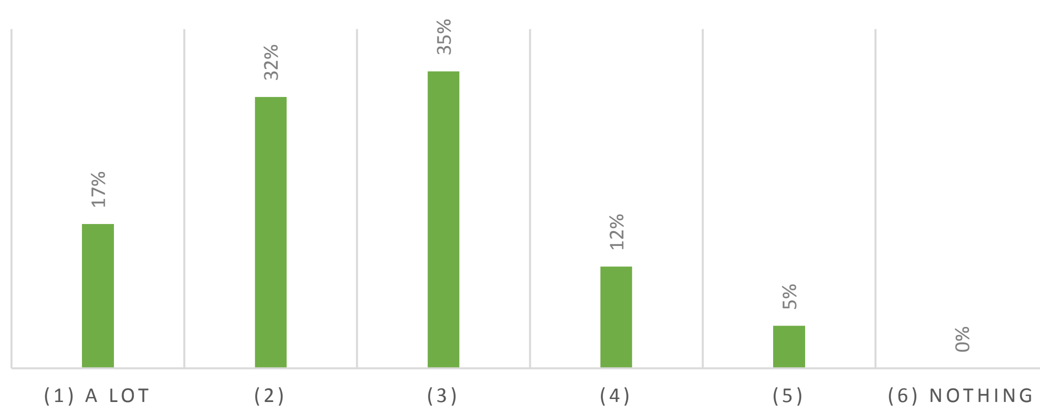


Figure 4.1. How much do you feel you know about climate change (1) a lot (6) nothing? (*n*=300)

One-way analysis of variance (ANOVA) showed those over the age of 55 years reported significantly higher perceived knowledge of climate change (*F(5, 292) = 2.38, p=.039)*. Further, an independent-samples T-test analysis indicated a significant difference between perceived knowledge of climate change based on gender, (t(297) = 3.1, *p<.002*), with males (*M*= 2.3, *SD*= 1.04) more likely to assess their own knowledge about climate change as higher than females (M=

2.7. *SD*= 1.05). A significant difference was also indicated between subject taught and perceived knowledge, ($t(296) = -2.54$, $p<0.012$), with science teachers *(M*= 2.23, *SD*=1.04) indicating they felt they knew more about climate change than non-science teachers (*M*=2.61, *SD*= 1.15).

Frequently surveys rely on an individual's self-reported knowledge of climate change as above. The current survey also employed eight questions addressing the science of climate change as one measure of ascertaining respondents' conceptual understandings of climate change. These questions were taken verbatim from Reser et al.'s (2012) study and were based on Sundblad et al.'s (2009, cited Reser, 2012) work. The results from the eight knowledge questions show some uncertainty relating to the science of climate change. While four (4) questions were answered correctly by more than 50% of respondents, only 2 questions were answered correctly by more than 60% of respondents. Compared with the Australian sample, overall the teachers who responded to this survey were more knowledgeable than the Australian general public and showed less uncertainty with their responses (see Table 4.1) (Reser et al., 2012), (i.e. fewer 'Don't know' responses generally than the Australian survey). However compared to the Australian sample a greater number of teachers were incorrect or held false understandings of the scientific concepts than the Australian general public. This result may indicate that while teachers are in general more knowledgeable and more confident in their knowledge of climate change science than the general Australian population, they are also more likely to be sure of the wrong answer rather than acknowledging they do not know.

The results also highlight a degree of questionability about teachers' science based knowledge of climate change, for example a majority of respondents answered three of the eight questions incorrectly. Various studies have indicated Australians in general hold low levels of climate change science knowledge (see for example: Ashworth, Jeanneret, Gardner, & Shaw, 2011; Gardner & Ashworth, 2007; Reser et al., 2012), with preservice and in-service teachers also being shown to be under-informed about climate science (Boon, 2009, 2010; Papadimitriou, 2004).

Table 4.1

Climate change knowledge questions

				Australian Survey findings (Reser et al. 2012)		
	TRUE %	FALSE %	Don't know %	TRUE %	FALSE %	Don't know %
The projected sea level rise provided by the IPCC (Intergovernmental Panel on Climate Change) for the remainder of the century (2099) is between 18 - 59cms	47.9	14.6	37.5	35	10	54
Australia is one of the most exposed nations with respect to projected impacts of climate change	57.2	30.9	11.9	44.3	24.1	31.6
Climate change will increase the risk in Australia for diseases transmitted by water and mosquitoes over the next 100 years	55	20.5	24.5	39.8	23.3	37
Globally, the current burning of fossil fuels accounts for 80-85% (CO2) emissions added to the atmosphere	45.6	29.5	24.9	47.1	15	37.9
Climate change is mainly caused by the hole in the ozone layer	5.5	87.5	7	20.6	57.8	21.6
Australia produces about 5.5% of the planet's carbon emissions	27.8	33.3	38.9	23.4	17.8	58.7
Australia's average temperature has increased by approximately 1C from 1910 – 2002	63.1	14.6	22.3	59.4	12.9	27.6
The number of weather related disasters around the world has doubled since the mid 1990s	42.5	26.9	30.6	47.4	15.6	37

Note. The correct answer for each question is shaded in the table. Reser et al. 2012, *n*=3096

Survey respondents were asked to rate the level of certainty they felt with their responses to the knowledge questions. Twenty-nine percent of respondents indicated a certainty rating of either five or six (6 = certain) when asked how certain they felt the answers that had given were correct (see Figure 4.2). This is compared with 47% of respondents who felt they were knowledgeable about climate change (see Figure 4.1).

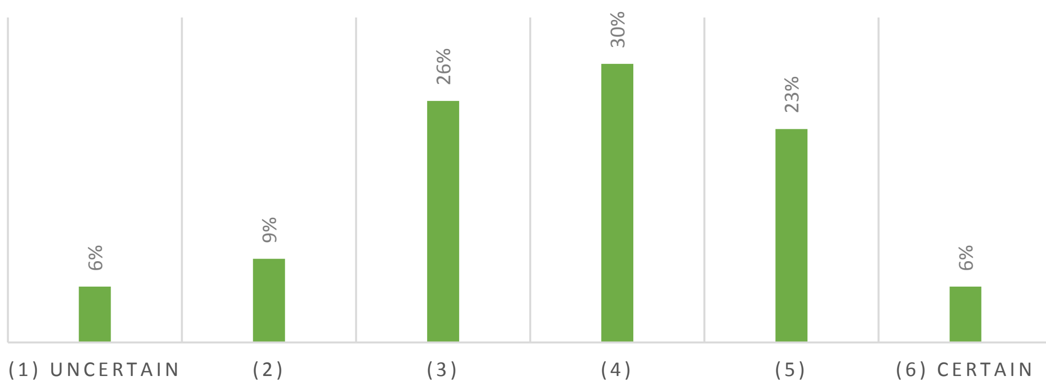


Figure 4.2. How certain are you about the correctness of the answers you have given to the above true/false statements (*n*=307).

Teachers' actual scientific knowledge is contrasted by their reported level of confidence in their own knowledge; respondents reported feeling knowledgeable about climate change (see Figure 4.1) and somewhat confident in the correctness of their responses to the knowledge questions (see Figure 4.2). The certainty rating given by respondents to this study was consistent with Reser's (2012) Australian study. Previous research has indicated the more important a topic is to an individual the more knowledgeable they tend to feel they are about it (Radecki & Jaccard, 1995). However, over confidence in actual climate change knowledge can have a negative effect on new information-seeking as individuals with higher perceived knowledge tend to be less willing to seek new information (Radecki & Jaccard, 1995; Sundblad, Biel, & Gärling, 2009).

Chi-square tests revealed a significant difference between science and non-science teachers' knowledge on objective knowledge question *Climate change is mostly caused by a hole in the ozone layer* ($x^2(4, N=298) = 10.01, p=.04$) and question *Australia produces about 5.5% of the planet's carbon emissions* ($x^2(4, N=294) = 7.05, p=.029$).

Additionally, chi-square tests indicate a significant difference between high school teachers' knowledge of climate change versus primary school teachers' knowledge on two questions: *Climate change is mostly caused by a hole in the ozone layer* ($x^2(2, N=289) = 14.36, p=.001$) and *Australia is one of the most exposed nations with respect to projected impacts of climate change* ($x^2(2, N=288) = 10.01, p=.04$).

No significant difference ($p>.05$) between science and non- science teachers' objective climate change science knowledge and high school and primary teachers' objective climate change science knowledge was found with the remaining six questions respectively (see Table 4.2). As such, science teachers within this study do not appear to be better informed, with the exception of the two items noted above, on specific climate science knowledge than their non-science teaching peers. Moreover, four of the eight questions were answered correctly by a greater number of non-science teachers. Year level taught also appears to have little influence on the climate change science knowledge of teachers in this study.

Low climate change science knowledge has been highlighted previously amongst pre-service and in-service teachers, including science teachers (see for example: Boon & Wilson, 2011; Boon, 2010; Plutzer et al., 2016; Wise, 2010). This finding suggests teachers receive limited preparation in climate change science within preservice coursework or in-service professional development. While subject knowledge alone is not sufficient for effective teaching and learning, subject knowledge does affect teacher practice including planning, interactive teaching and reflection (Sanders, Borko, & Lockard, 1993). Hashweh (1987), for example, found secondary biology and physics teachers' knowledge of the topic

Table 4.2

Objective knowledge questions separated by subject taught

Knowledge question	Right answer %		Wrong answer %		Don't know %	
	Science	Non-science	Science	Non-science	Science	Non-science
The projected sea level rise provided by the IPCC (Intergovernmental Panel on Climate Change) for the remainder of the century (2099) is between 18 - 59cms.	47.3	47.6	17.6	14.6	35.1	37.7
Australia is one of the most exposed nations with respect to projected impacts of climate change.	47.3	59.9	40.5	27.4	12.2	12.7
Climate change will increase the risk in Australia for diseases transmitted by water and mosquitoes over the next 100 years.	56.2	55.4	24.7	18.3	19.2	26.3
Globally, the current burning of fossil fuels accounts for 80-85% (CO2) emissions added to the atmosphere.	40.5	47.9	36.5	26.3	23	25.8
Climate change is mainly caused by the hole in the ozone layer.	97.3	84	1.4	7.1	1.4	9
Australia produces about 5.5% of the planet's carbon emissions.	43.8	27.1	23.3	32.4	32.9	40.5
Australia's average temperature has increased by approximately 1C from 1910 - 2002.	67.1	62.4	12.3	14.6	20.5	23
The number of weather related disasters around the world has doubled since the mid 1990's.	34.2	45.8	31.5	24.5	34.2	29.7

Note. Science teachers *n*= 74, 24.7%, Non-science teachers *n*= 213, 71.2%

being taught affected lesson planning, ability to modify and present textbook content, and lesson structure.

Alongside low specific content knowledge, misconceptions about the topic to be taught also influence teachers' planning and instruction. Misconceptions about an issue or topic can endure even when evidence dispelling the misconception can be found in teacher preparation materials (Hashweh, 1987). Misconceptions about climate change are held by many individuals (Bostrom, Morgan, Fischhoff, & Read, 1994; A Leiserowitz, Smith, & Marlon, 2010; Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007), including preservice teachers (for an Australian example see Boon, 2010). A prominent misconception held by many in the general public involves the conflation of the hole in the ozone layer with the issue of climate change (Bostrom, Morgan, Fischhoff, & Read, 1994; Leiserowitz, Smith, & Marlon, 2010; I. Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007). Encouragingly, the majority of respondents to this survey did not make that mistake. Only six percent of respondents incorrectly answered the question 'climate change is mostly caused by the hole in the ozone layer' compared to 21 percent of the Australian general public (Reser et al., 2012). Further, seven percent of respondents were unsure or answered 'Don't know' to this question compared to 22% of Australian respondents in Reser et al.'s (2012) survey. These findings are noteworthy in that while misconceptions are still prevalent, some misconceptions may be less in certain groups of the population, for example teachers, although the teachers within this sample may be atypical and results should be interpreted with due caution. There appears to be some evidence within the literature of "reduced confusion [between 1992 and 2009] about the relationship between ozone depletion and climate change" (Reynolds, Bostrom, Read, & Morgan, 2010, p. 1534), however, other research suggests this misconception remains significant within the Australian context (Ashworth et al., 2011).

At face value the above results may indicate teachers are not well informed about climate change and are overly confident about the knowledge they do have. These results suggest that using self-reported knowledge of climate change may be of limited value for determining a population's actual knowledge. However, closed answer knowledge questions have the potential to influence respondent engagement with the survey. When confronted with these types of knowledge questions some respondents may feel compelled to answer the question or to take an educated guess rather than select the 'don't know' option (Nadeau & Niemi, 1995). Further, the knowledge questions asked were highly specific, relating to precise details of climate change science, and may not truly reflect the wide range of knowledge and understandings held by respondents about climate change, or climate change science. Conceptual understandings of climate change encompass many facets including knowledge of climate change science, causes and/or consequences of climate change, or actions that can be taken to mitigate the effects, or adapt to the consequences of change. With the above in mind, the knowledge questions within the survey were just one means of assessing climate change knowledge and of investigating teachers' understandings of climate change.

As understandings are not easily isolated and narrow knowledge questions about specific climate change science may present a misleading picture of the breadth or depth of teachers' knowledge or thinking about climate change, the interviews further encouraged teachers to explore their conceptual understandings of climate change through open response questions. These questions provided an opportunity for teachers to convey a wider knowledge base than eight knowledge questions alone could allow. The teachers were asked to comment on their understandings related to the causes and consequences of climate change. Understandings of the scientifically supported causes of climate change understandably ranged from basic to more complex. Basic understandings of the causes of climate change were reflected in statements such as:

> *No I, I am thinking do I actually know. I sort of have a core belief about climate change, but um you've just challenged what I know. I believe people have 'an' impact. Um, I believe there have been fluctuations in the past related to the environment as a whole, as the way it operates as a living entity, but no I can't think of any direct causes [F, 35-44, NS, P].*

> *Um, natural occurrences [M, 45-54, S, H3].*

Some participants responded with more complex understandings of the Earth's climate, with one response referring to the Earth's orbit around the sun and life on Earth's historical and current day impact on climate. More commonly however, responses appeared to be reasonably informed, general in nature, and include reference to anthropogenic influences on climate including the burning of fossil fuels, methane from cows and/or deforestation:

> *Fundamentally, I suppose, it's the release of greenhouse gases and that includes carbon dioxide but also methane from agriculture and storing various things. Um, it's got something to do too, at a lower level, with the loss of forests because that changes the albedo of the earth, and my understanding of it is that a lot of these things are compounded by feedback loops that, for example, the melting of the arctic ice increases the amount of heat that the earth absorbs because the waters darker than ice so more energy gets absorbed by the surface. So you know the basic thing is about greenhouse gas emissions and then the feedbacks loops kick in from there [M, 55-64, S, H1].*

> *Emissions from fossil fuels in particular, notably coal and oil in transport and what not. The release of methane through I suppose, various mechanisms, that will include effects like the thawing of the tundra and other kinds of vegetation, other kinds of whatever, some of that will relate to human activity such as deforestation. Yeah, I would see the main one or the main two really as deforestation and emissions from our use of fossil fuels [M, 45-54, NS, P1].*

These results illustrate the range of responses from teachers about the causes of climate change. In many cases teachers expressed accurate portrayals of the current scientific position on climate change, however these descriptions were often narrow in scope. When discussing climate change, teachers frequently spoke of carbon dioxide emissions and a small number of other anthropogenic influences on climate along with warming temperatures. The immediate and intuitive response of teachers was dominated by anthropogenic influences on climate and temperature increases. Teachers infrequently spoke of consequences outside of temperature rises unless prompted and rarely of mitigation and/or adaptation ideas. Interestingly those participants who provided more complex descriptions when asked about the causes of climate change were not necessarily those who held strong convictions or were sure of the science of climate change. Further, most respondents discussed anthropogenic influences on climate change regardless of their personal acceptance of anthropogenic climate change.

This limited initial frame of reference teachers used when thinking about climate change may have been shaped by the media and political discourse at the time of the surveys and interviews. The public discourse at the time of this research was heavily dominated by talk of a carbon pricing mechanism, or so called ‘carbon tax’, that was introduced by the then Government of Australia. Australian media and political spheres were focussed on carbon pollution and the need to (or not) reduce carbon emissions (Bacon, 2013). This dominant polarised public discourse may have shaped the way in which teacher participants were thinking about the issue of climate change, including immediate conceptions or frames of the issue as well as risk perceptions. This limited discourse, of which teachers are a part, was restricted to causes.

4.1.3 Beliefs

Personal beliefs about climate change, including but not limited to the causes and consequences of climate change, are another dimension related to teachers' understanding climate change. The results relating specifically to participant beliefs about the causes and consequences of climate change will be presented under subheading 4.3 *Teachers' personal beliefs about the causes and consequences of climate change,* to specifically answer sub research question three. Results relating to beliefs about climate change science and scientists are presented here.

A large majority of survey respondents believed that most scientists agree that humans are causing climate change, with 72% either strongly (37%) or tending to agree (35%) (see Figure 4.3). The teacher participants elaborated on this belief with most indicating they felt scientists studying climate change were fairly certain that the climate was changing and humans were, in part at least, responsible. Respondents showed varying levels of nuance in their responses:

> *They can only observe patterns. That's all they have available to them and based on the best knowledge available to them this is the message that they are sending out, um and those of us that are non-scientific probably shouldn't be arguing [F, 35-44, NS, H1]*

> *I think that the evidence that they have processed still supports the hypothesis that human activity has changed the climate and continues to change the climate. I think they're as close to 100% as you can ever be of a hypothesis, however I think what's been really interesting is that their extrapolations about the way in which this climate change would happen has had to change. They've noticed that in the last 15 years the thermal temperature, you know the air temperature of the earth, has not continued to rise up as predicted so they've had to rethink, does that mean that the energy that was building up in the atmosphere has now started to be absorbed effectively by the oceans. And I still think that they are as close to 100% that humans have contributed to climate change and continue to do so, but it's been I think there has been a shift in their simplistic assumptions about how it is going to happen [F, 55-64, S, H2]*

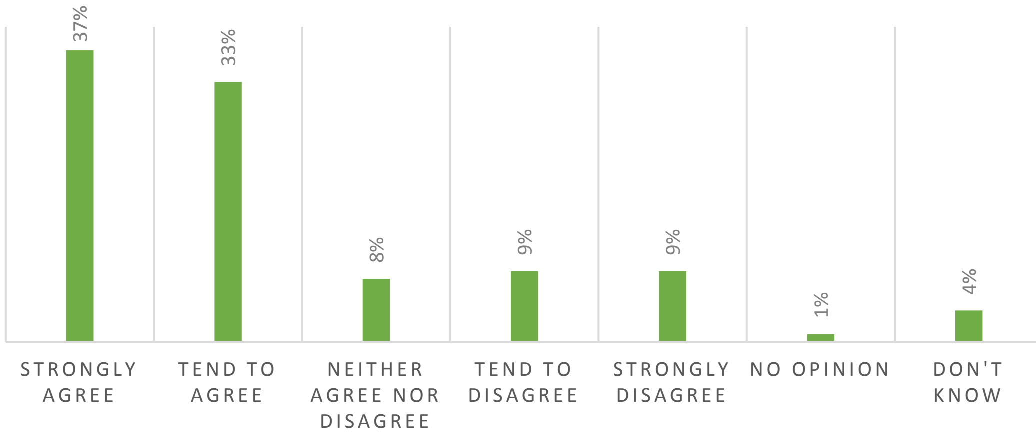


Figure 4.3. Most scientists agree that humans are causing climate change (*n=309*).

A small number suggested the 'sureness' of scientists was influenced by factors other than evidence:

> *Being human beings some of them are very certain, some of them it is perhaps grey, and when I say very certain they're either very certain that it is happening or very certain that it isn't happening, you know there are human beings so you've got the whole gamut. Like your personality type and how you were raised or whether you are a Liberal or a Labor voter must effect you and what drives your thinking as far as economics goes and where you think the world should be heading as far as population and whatever so yeah every scientist would be influenced by their own personal beliefs [F, 55-64, NS, P3]*

> *Well a lot of the times it will just focus on one thing and not look at the big picture sort of stuff. And if a scientist has been funded by a certain organisation they will look for evidence that will keep them happy. If I was a scientist and I wanted to do some work, if Greenpeace were funding me as opposed to ah say the coal industry I could come up with two different sets of data that would be equally correct but could be looking at things from completely different angles. We tend to look at all the sort of things that will support whatever position that we have [M, 45-54, S, H4]*

The necessity or appropriateness for public debate about the science of climate change was an area where views were wide-ranging. Some felt debate about the science of climate change within the public sphere was inappropriate. A small number of teachers argued climate science was not suitable for public debate:

> *I don't like it because to me it's not really up for debate, it just is … and it gives people the thought that they can believe it or not. It's up there with something like religion, 'hey let's have a talk about it and you know nobody is ever really going to know the truth' and no I don't equate it with the same thing so I don't really think it is up for debate [F, 45-54, S, H4]*

While some felt that debate about climate change science among laypeople is inappropriate many others believed public debate about the science is helpful and necessary:

> *I think it is really important. I think all controversial ideas should be debated and people's concerns or uncertainties need to be aired and need to be addressed [F, 55-64, S, H3]*
>
> *I suppose so, so people can hear both sides. I guess [F, 65+, NS, T1]*

Others felt debate was helpful but with some caveats:

> *Well debate is fine as long as they look at the facts rather than look at what they feel might be the case. If it's prompting a genuine debate with scientific evidence being presented in an objective manner then that's fine. But unfortunately too often the media does not do that, they tend to try and set it up not as a debate but as an argument … I think it's helpful but I need to say that with caution because unfortunately far too many people in the public do not understand the difference between fact and fiction [M, 55-64, S, H5]*

Many teachers believed that anthropogenic climate change should be debated publically. The notion that there are two equally weighted scientific 'sides' or arguments relating to the existence and cause of climate change that need to be debated in order for the public to decide, further questions teachers' understandings of the nature of science and implies that teachers view climate change as a politically controversial issue where 'science' can be publically debated in order to determine the 'truth'. Climate change science is complex and the theory that humans are influencing the Earth's climate relies on multiple sources of evidence from various scientific disciplines. The view that scientist 'A' could publically debate scientist 'B' on the evidence of anthropogenic influences on climate then allow the public to determine the answer, relies on a simplistic or erroneous understanding of science and a lack of understanding of the inherent complexity of the issue.

Most teachers were not questioning the integrity of scientists. This position was held by teachers who at the same time stated they trust scientists to provide accurate information about the environment and felt that scientists were confident that humans are having at least some influence on the climate. While trust in scientists was high, trust in the government and media was low. Some teachers felt that the message from scientists may be being distorted by the media and government for their own ends. One teacher summed up this sentiment:

> *I don't know because it's getting it past the government and past the media where, you know, they're such a huge influence on society on the messages that we receive. I'm sure that they* [scientists] *are already trying to get that message out, and have been for decades, but whether that's coming out the way they want I don't know um... I personally, you know, to have any faith in it I want to go to a scientific publication but they're typically very expensive and hard to find [F, 35-44, NS, P1].*

Teachers indicated a general sense of confusion, mistrust, and uncertainty about the issue of climate change, suspecting that they were not able to know the truth as too many vested interests stood between them and 'the facts'. This lead to some confusion amongst teachers about what the scientific position on climate change actually is. This raises questions about why such confusion exists.

A small number suggested public debate should centre on policy or actions rather than the science:

> *So I think what would be better debated would be what we can actually do about it, or what we are going to do about it. So it's interesting to listen to people who are actually taking that attitude now, that we had the debate, the supposed debate, now we all know what's gonna happen, so how are we going to solve that. Probably be a better thing to be debating [M, 55-64, S, H1].*

4.1.4 Risk perceptions

As noted previously how individuals understand climate change is complex. When considering how teachers understand climate change, risk perceptions or judgements about the seriousness and degree of threat climate change poses is an important consideration. A number of survey questions explored respondents' beliefs about the risks posed by climate change. Over 50% of respondents believed climate change is a serious (5=25%) or very serious (6= 31%) problem currently (see Figure 4.3).

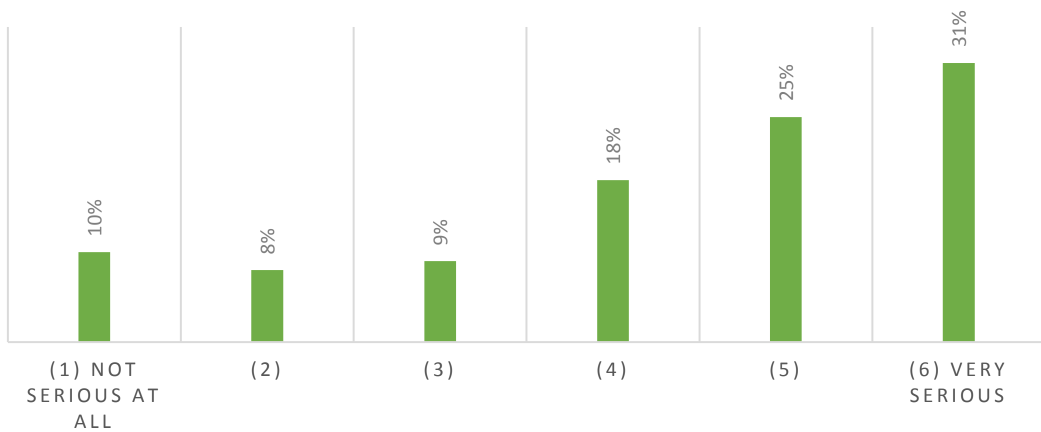


Figure 4.4. How serious a problem do you think climate change is right now? (*n*=308).

The majority of respondents to this survey recognised climate change poses risks to the Australian general public with 77% of respondents indicating they 'strongly' (48%) or 'tended to' (29%) agree with the statement "*there are risks to people in Australia from climate change*" (see Figure 4.5)

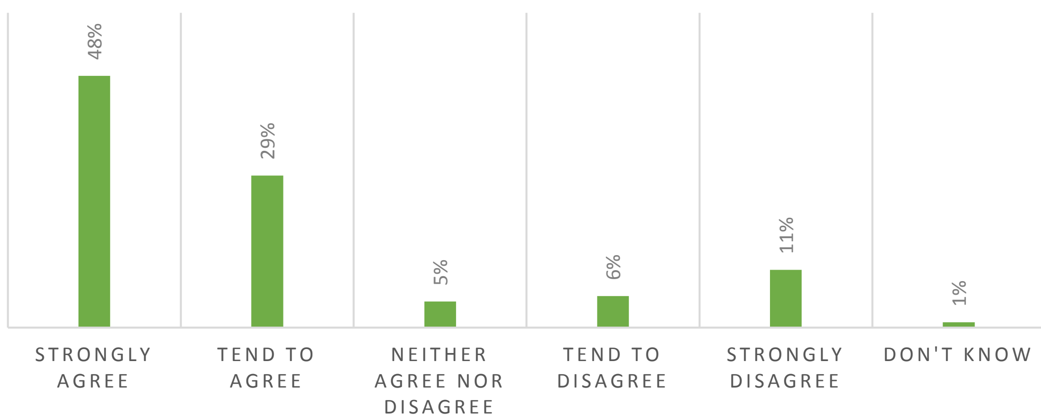


Figure 4.5. There are risks to people in Australia from climate change (*n*=308).

Further, although a substantial minority (28%) believed the seriousness of climate change is exaggerated, the majority (64%) of respondents felt the seriousness of the issue is not (Figure 4.6). No statistically significant relationship was found between perceptions of risk to Australians and gender, age or level of education ($p>.05$).

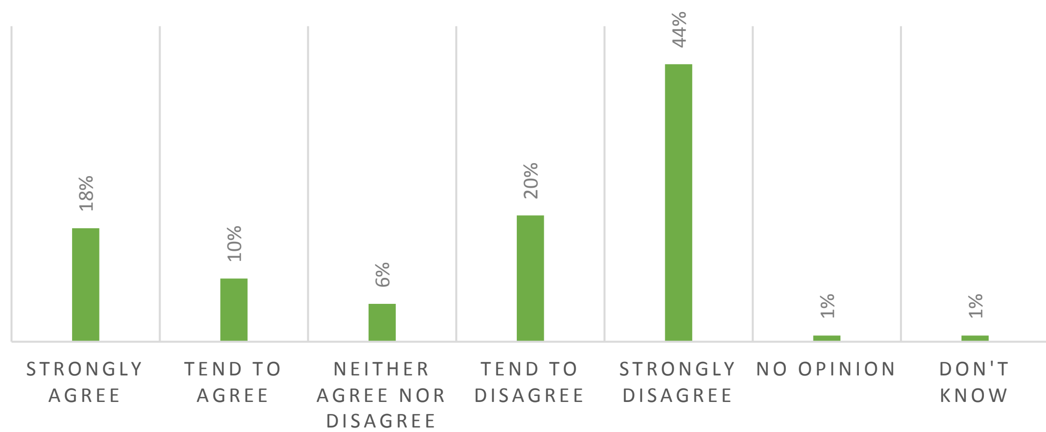


Figure 4.6. The seriousness of climate change is exaggerated (*n*=309).

The survey results relating to risk perceptions overall suggest that a majority of Queensland teachers view climate change as a very real risk to the Australian public. However, although the majority of survey respondents indicated that climate change was a serious problem and that there were risks posed to Australians from climate change, the interviews revealed that these risks were not seen by teachers as immediate or personal. Teachers did not immediately associate climate change with real or immediate consequences to themselves, their immediate surrounds or other local implications. When questioned about the consequences of climate change, all participants spoke of consequences in the future in a broad global sense and rarely considered any local or personal connection. Participants felt they themselves were not likely to be affected by climate change. This position reflects risk perceptions held by the wider Australian community. In general individuals living in developed countries view climate change as removed from their daily lives, geographically as well as temporally (Lorenzoni et al., 2007) and commonly view the risks to them posed by climate change as insignificant (Lorenzoni & Pidgeon, 2006). Distancing of environmental problems, lack of appreciation of immediate environmental threats, and perceiving environmental issues as more worrisome when they take place at a distance from the observer has been called environmental hyperopia (Uzzell, 2000).

When prompted, some respondents noted there may be future impacts to them, with a small number concluding they were already feeling the effects of climate change where they live. Others did not view climate change as a threat to themselves personally due to their location or believing they will no longer be alive when climate change impacts are felt (this position will be detailed further in Section 4.3.2). In a general sense, interviewees did not express immediate urgency or risk for themselves, however some expressed concern for future generations and a sense of importance that action now was needed to help prevent the worst of future impacts. Like the teachers in this study, within Australia, individuals are generally concerned that climate change may worsen (Agho, Stevens, Taylor, Barr, & Raphael, 2010). However, within Australia, climate change is seen as a low priority amongst other general and environmental concerns (Leviston, Price, Malkin, & McCrea, 2014).

Research suggests individuals may perceive the risk of climate change to be higher when the risks posed are overt (Brody, Zahran, Vedlitz, & Grover, 2008). Individuals who have experiences with risks associated with climate change or who live in flood prone or low lying areas are more likely to register a perceived risk (Brody et al., 2008). Participants within this study who had experienced severe weather related events mentioned these as justification for ongoing perceived risk, for example participants who had experienced the Brisbane flood events of 2011 recalled these experiences when discussing their future potential for risk associated with climate change and severe weather events. However, those teachers that felt climate change was going to, or already was, affecting them still did not indicate high levels of concern.

Teacher feelings of risk may also be influenced by their knowledge of future climate change impacts (Bord, O'Connor, & Fisher, 2000; Milfont, 2012; O'Connor, Bord, & Fisher, 1999; Reser, Bradley, Glendon, Ellul, & Callaghan, 2012). As with literature exploring climate change beliefs, climate change risk perceptions have also been linked to an individual's knowledge and understandings (Leiserowitz, 2006). Teachers did not appear to hold complex, or highly accurate understandings of the projected risks associated with climate change to their local area or to themselves, and this lack of knowledge may lead to lower risk perceptions (Brody et al., 2008). However like beliefs, risk perceptions have been associated with broader contributing factors than an individual's knowledge of the issue, for example, core values have been shown to influence individual risk perceptions (Kahan & Braman, 2006; Kahan, Braman, Slovic, Gastil, & Cohen, 2007; Kahan, Jenkins Smith, & Braman, 2011). Interview participants' responses to questions relating to risk and consequences will be explored in further detail in section 4.3 *Teachers personal beliefs about the causes and consequences of climate change.*

4.1.5 Responses to climate change

Teacher interview participants were asked if they believed anything could or should be done in relation to 'current' climate change. For those that felt something could be done, the overwhelming response was in terms of mitigation; adaptation was not identified immediately as a response to current climate change by any of the participants. Participants primarily referred to reducing energy use or reducing the burning of fossil fuels. Of those that identified mitigative strategies many were pessimistic about the likely success of such actions:

> *I would like to think so, I think we are in theory capable of changing aspects of the way we live personally, and at a political level obviously, to do with the kinds of industry that we invest in. I have to say that I am fairly pessimistic about whether we will in fact make those changes on a global.., we'll never get enough to actually effect anything [M, 45-54, NS, P]*

Theoretically yes absolutely, we change the whole way the earth works economically, and it could all be tackled, but realistically, no I don't. I mean you've got the perfect example is [sic] our carbon tax. You know we were ahead of the rest of the world just about in putting that in place and the most common thing that I heard from people who disagreed with it was; 'why would we bother when the other major polluting countries aren't doing a thing? It won't make any difference to the level of pollution in the world and the level of carbon that's being released or sorry the level of CO2 that's being released'. So no I don't think anything is going to happen [F, 55-64, NS, P3]

I think it's terrific that Obama for instance has concerns about climate change, even though America hasn't done anything near as much as it could. Our current federal government expresses its concerns but again I see very little action and their proposed action looks likely to be particularly ineffective [M, 45-54, NS, P1].

Teacher interview participants overwhelmingly believed that individual actions were necessary and could be effective, however, little held faith in enough individuals taking action on their own. For effective responses to climate change interview participants believed governments both nationally and internationally would have to take action:

Well all of us need to act on it but without the, if you like the highest levels, the national and international levels acting and expressing significant concern about it I think the other levels tend to consider it not so important [M,45-54,NS, P1].

Nations themselves have to start taking action but they only serve as a model then to other nations and then I think eventually it has to become a global approach, if there is any chance of it being successful…Individual action would [be enough] if enough people take it up… we've had solar, solar hot water for 20 years and we've gone through and put solar panels and things like that, but it has to be a situation, while what we are doing is contributing in a small way, it has to be done on a large scale and it has to be attractive enough for people to be able to do so… I think in the society and culture that we live in on a worldwide basis there has to be government action, to be a government initiated thing in some way for it to be taken up on the scale that it needs to be taken up on [M, 55-64, S, H5].

To further explore Queensland teachers' perceptions of responses to climate change survey respondents were asked to indicate their level of agreement with a number of statements on a scale of one (1) strongly disagree to six (6) strongly agree. The opinion amongst survey respondents was diverse to the statement: *I believe that climate change is inevitable, no matter what we try and do to stop it* (see Figure 4.7). Responses were slightly more optimistic to the statement: *Humans have little control over the force of nature such as climate change* (Figure 4.8).

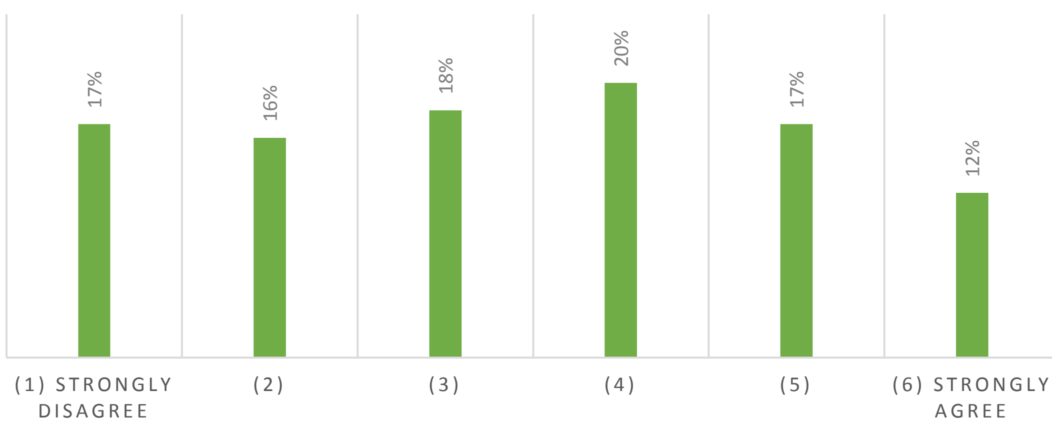


Figure 4.7. I believe climate change is inevitable, no matter what we try and do to stop it *(n*=309).

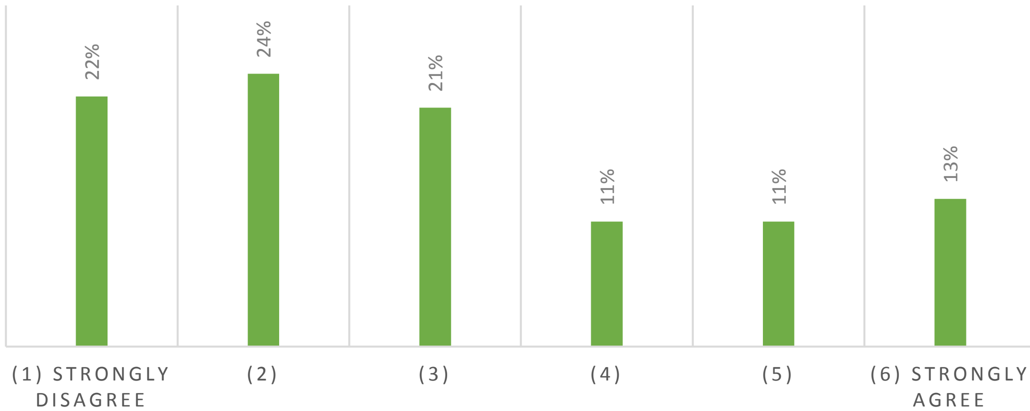


Figure 4.8. Humans have little control over the forces of nature such as climate change (*n*=307) *note*. Totals equal greater than 100% due to rounding.

When prompted a small number of respondents felt adaptation may be necessary for some people in the future:

> *I certainly think there are countries that will need to do that. I think mitigation in a global sense is unrealistic. I think we are going to continue to have CO_2 emission and I think it is going to increase. I don't think it is going to stabilise anytime soon. So that means if sea level rise is going to be a metre by the end of this century, then yes I think there are certainly countries that are going to have to think well we'd better just look at what's going to happen and try and safe guard our population and economy [F, 55-64, S, H2]*

Adaptation to climate change effects was something the vast majority of teacher interview participants were not actively thinking about or engaged with.

4.1.6 Engagement

Although interviewees were pessimistic about individual actions being taken and often suggested global and national government action was the only likely successful mitigation tactic, survey respondents indicated a more positive outlook on their own individual actions. The majority of respondents felt that their own actions have an influence on climate change, with 62% of respondents agreeing (5) or strongly agreeing with this statement (see Figure 4.9). There was also a hopeful sentiment expressed by a number of respondents relating to the belief that personal actions within the community had a positive effect on others' actions (Figure 4.10).

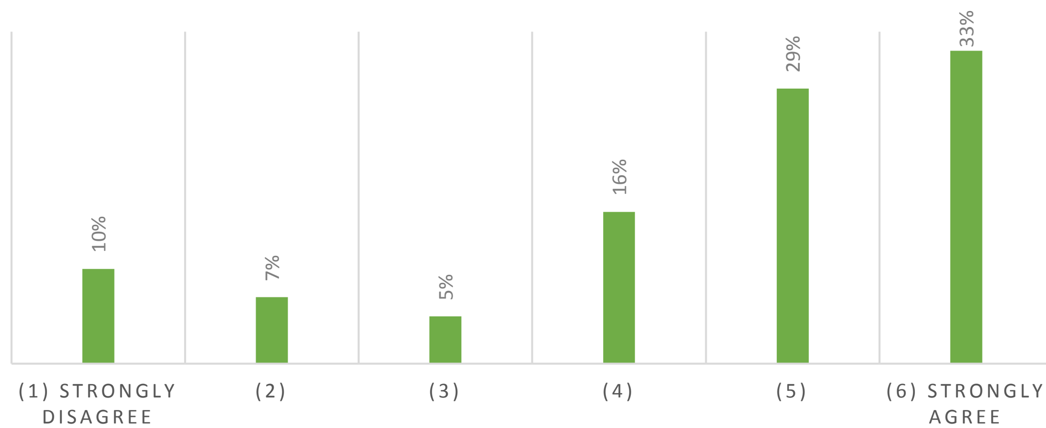


Figure 4.9. I believe my actions have an influence on climate change (*n*= 308).

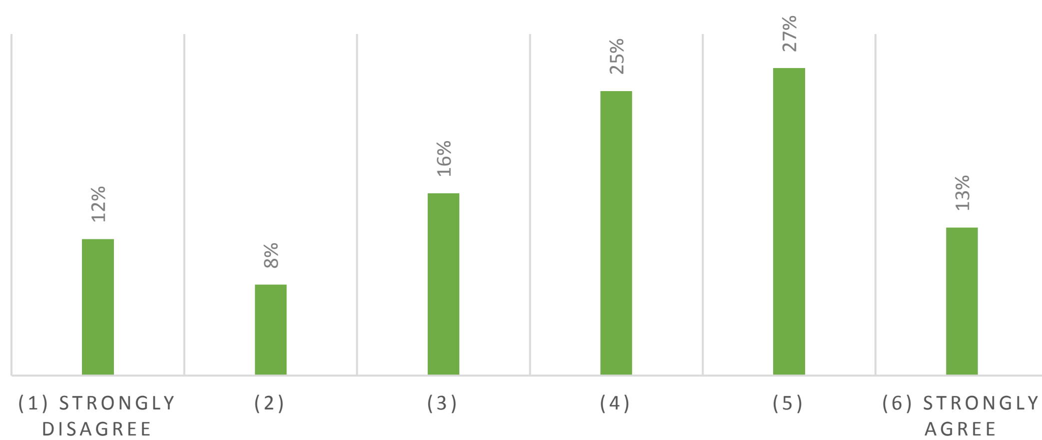


Figure 4.10. My actions to reduce the effects of climate change in my community will encourage others to reduce the effects of global warming through their own actions (*n*=309). *Note*. Totals equal over 100% due to rounding.

Survey respondents also indicated their own personal actions influenced how they were feeling and thinking about climate change and environmental problems more generally. A large number of respondents believed their actions positively influenced their thinking and feeling about climate change and environmental problems more generally (see Figure 4.11).

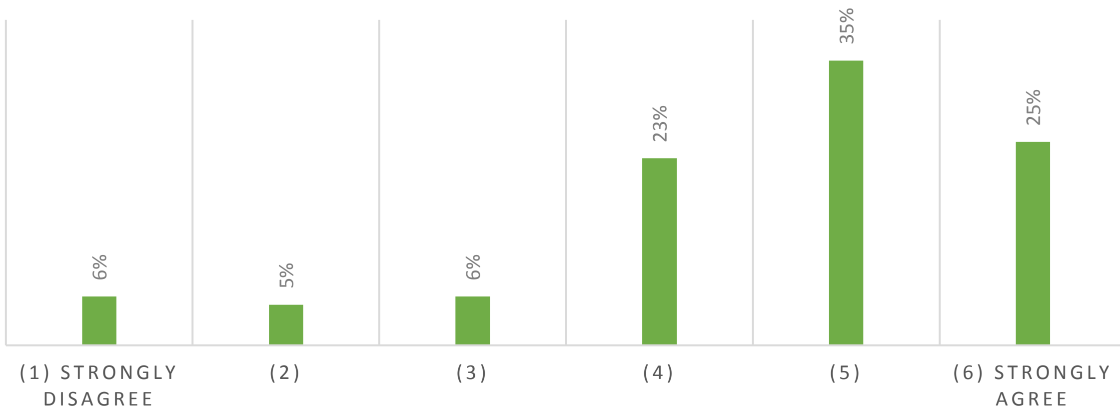


Figure 4.11. I believe my actions have a positive influence on how I am feeling and thinking about climate change and environmental problems generally (*n*=308).

The teachers within this study felt something should be done about climate change and these findings echo other studies conducted within Australia and globally (see for example Bulkeley, 2000). Importantly, survey respondents stated they felt their personal actions had a positive influence on how they were thinking and feeling about climate change and other environmental issues generally. Further, a number of survey respondents felt their actions had a positive affect within their community. However, as previously mentioned, during interviews teachers expressed that they feel individual actions will be **ineffective**. Similarly, past studies have shown that few people feel personal actions have the capacity to reduce the effects of climate change, or that the responsibility to act was located with others, including governments, businesses, industry and other countries (Lorenzoni et al., 2007).

Powerlessness or feeling a lack of efficacy in personal actions is a complex influence on individual decision making. For example, powerlessness to effect change can make individuals less likely to take action on climate change (Aitken, Chapman, & McClure, 2011). Aitken et al. (2011) found that individual powerlessness to affect change was linked to an unwillingness to act on climate change unless others take action. These authors argued powerless in this instance is linked less to the efficacy of one's own actions but more to the inactions of others. Teachers interviewed within this study also acknowledged they were pessimistic about group action, believing too few people will take action to achieve any significant effect. Teachers felt that no real change can be affected through voluntary individual actions alone due to the failure of others to take part, but have more faith in group action if mandated or supported by government policy and action.

Regardless of these beliefs, teachers still believed individuals should be acting in any way they can to help mitigate climate change. Notably, these discussions were in the context of mitigating climate change, while adaptation or preparing for the effects of change was not evident in teachers' thinking about climate change. Very few interviewed teachers associated climate change with adaptation with no participant discussing adaptation without direct prompting.

4.2 Sources of information teachers use to inform themselves about climate change

Survey respondents were asked how closely they were following news about the environment these days. A small percentage of respondents indicated they were not following news about the environment at all (3%) and 16% of respondents indicated they were following the news about the environment a great deal (6 – A great deal) (see Figure 4.12).

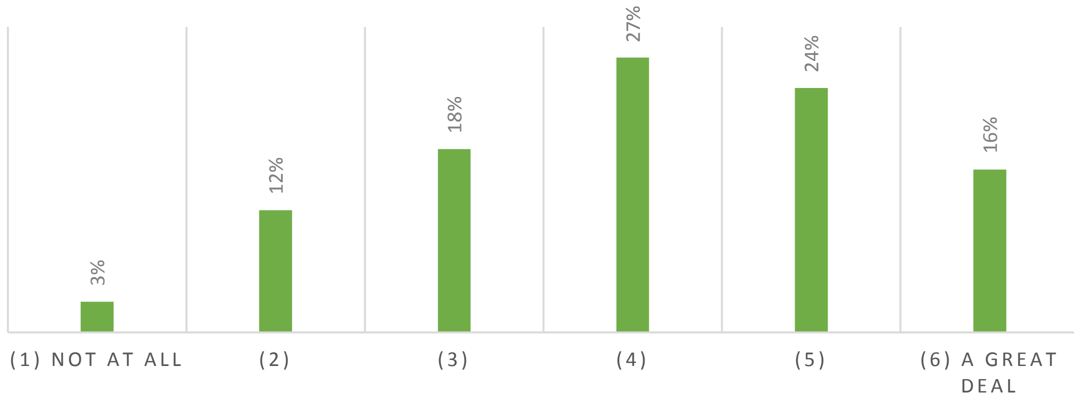


Figure 4.12. How closely are you following news about the environment these days? (n=305)

Respondents to this survey were asked how much they trusted communication about the environment from different sources (Figure 4.13). Information sources surveyed were: the media, the government and scientists. The survey results indicate teachers view scientists as trustworthy sources of information about the environment, with trust in scientists higher than both the media and government. No respondents (0%) completely (6) trusted the media or government to be trustworthy sources of information relating to the environment.

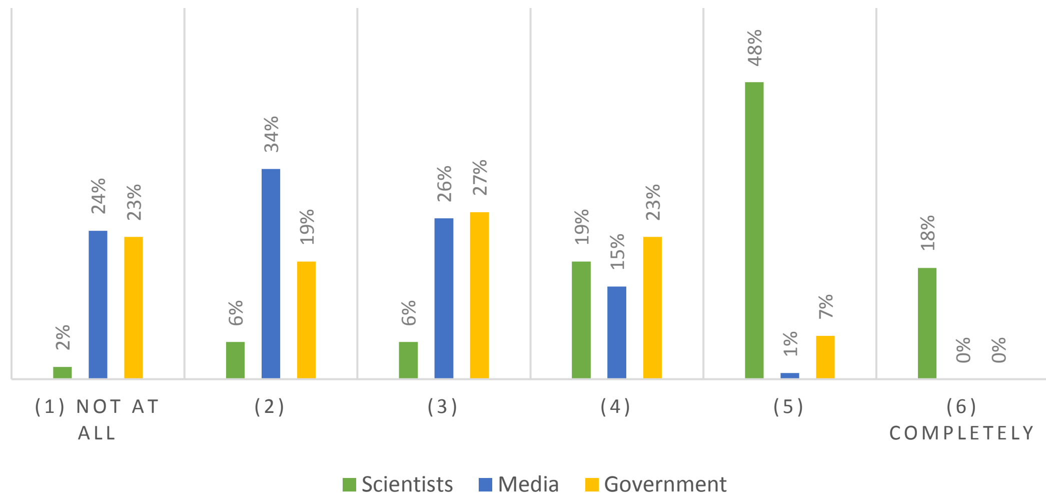


Figure 4.13. How much do you trust what different sources say about the environment? Scientists (*n*= 308), Media (*n*=308), Government (*n*=307). *Note.* Totals may not equal 100% due to rounding.

The lack of trust in media and the government was explored further in the teacher interviews where participants also expressed a lack of trust in media and the Government:

> *I think the Australian Newspaper is hilarious in what, in how it betrays climate change. So um, the only place I actually go for information that's linked loosely to news these days is 'The Conversation' ah which ah is essentially academics trying to contribute base research and data to um you know, to the public domain [M, 35-44, S, H2].*

> *Well I don't trust the Murdoch press other than something, you know as, something to disparage [M, 55-64, S, H1].*

Teacher participants were asked why they did not trust the media or government to provide accurate information. Participants explained that media bias and partisan political motivations made both sources unreliable:

Governments will always put their own spin on it… When the CSIRO is reporting and they are not being quoted by a politician then yes I believe them to be a reliable source. Unfortunately too many politicians tend to paraphrase [M, 55-64, S, H5]

They [newspapers] sort of have a hidden agenda to push. I mean you'd like to trust them, and it depends ... I think it depends on the article and the particular publication. I think some are more reputable than others and you can sort of tell by the way they're written or who they are sighting [sic]. Is it just someone telling you what they think or you know? And it's also the government, political things coming into it too. You know, if certain people say one thing I might think yeah I don't think so (laughing). But if somebody else says it I'm probably more likely to believe it [F, 25-34, NS, P2]

One participant, who indicated feeling confused about what was known and or unknown about climate change, explained how lack of trust in the media and government left this individual unsure of what scientists really know or believe about climate change. This participant emphasised trusting scientists to be honest and reliable sources of information, however felt unsure of scientists' positions on climate change. The individual felt the message flowing from scientists to the general public was not trustworthy as it was filtered through media and political channels, each with their own personal agendas. As a result the participant felt unsure of the scientific position:

I would expect and I would hope that they are fairly sure. My doubt comes from the message getting from the climate scientists though the media, through the government to the people. I don't know whether we're receiving the information that the climate scientists wish we would have, but I hope that they would know what is happening, for sure. Or certainly have an understanding of what's happening [F, 35-44, NS, P1]

This teacher expressed the wish to be able to hear about climate change directly from a scientist:

> *I mean directly from somebody's mouth creates far less chance of a bias or influence [F, 35-44, NS, P1]*

Most teachers would rarely interact with a scientist working in a field related to climate change and few have indicated they actively seek climate change information through peer reviewed scientific journals. With the limited time and perhaps capacity to access and process complex scientific information many individuals rely on mass media to understand and communicate important or salient issues about climate change (Akter & Bennett, 2011; Corbett & Durfee, 2004; Whitmarsh, 2009). The teachers within this study indicated while they typically do not actively seek information on climate change, they too access climate change information largely through mainstream mass media by purposely reading, watching or listening to news articles that are related to climate change. Although teacher trust in the media appears to be low, both survey respondents and interview participants indicated they used the media, and in many cases amongst interview participants, only the media, to inform themselves about climate change. When questioned, interview participants frequently cited newspapers, radio and television as a primary source of information about the topic. Yet some teacher participants spoke of not completely trusting these sources and the need to critically assess the reliability of the messages being portrayed through personal judgement:

> *I read newspapers; I still read paper newspapers not online. Magazine articles, you know like National Geographic and New Scientists and Time and all those. Some television stations, you know I watch a lot of nature programs and documentaries and things. When I used to listen to the radio, and I still do occasionally or a radio program so if there was one that I wanted to hear I'd listen to that. Ah, like television, like there was an*

interview with David Suzuki I think he was special guest on Q&A last week, that sort of thing [F, 55-64, NS, P3]

The general media, the Courier Mail is probably the other source of my news and I always look at who has.., who the author of a particular article is and just bear in mind where it is situated. How relevant it may or may not be and why it is in that particular day [F, 35-44, NS, P1].

When actively seeking information about climate change the interview participants primarily stated they use the internet. Many stated they used the internet to access scientific content or websites including government websites such as the Bureau of Meteorology (Australia), or The CSIRO website (Commonwealth Scientific and Industrial Research Organisation, Australia), to access news media, and also for general 'Google' searches:

The Internet, that's where you'll get the most current information [F, 35-44, NS, H1]

Well the BOM site, the Bureau of Meteorology site has been building up information it provides about climate change over the years. NASA sometimes put out good ones, sometimes some of the articles are a bit too scholarly for me, I look at them and go oh I don't know what they are saying. So yeah I wouldn't say any particular source, I just take a look through the ones that crop up and some of them are obviously websites driven by fanatics and others are websites that are too scholarly for me so I just try and find something in between [F, 55-64, S, H2]

Survey respondents were asked to select where they mostly inform themselves about climate change. More than one option was allowed. Television documentaries were most frequently cited as the primary source used to inform survey respondents about climate with 53% of all respondents selecting this option. Online news websites (20%) and academic journals (19%) were the next most frequently cited sources of information. Survey respondents selecting other most frequently cited internet websites as their primary source of information followed by magazine publications.

4.3 Teachers' personal beliefs about the causes and consequences of climate change

Further to data presented above, teacher beliefs about the causes and consequences of climate change will be explored here in more detail.

4.3.1 Causes

A large majority of those surveyed either 'strongly agree' (56%) or 'tend to agree' (23%) with the statement '*I am certain that climate change is really happening'* (see Figure 4.15). This question did not include any reference to attribution of causes or influences on climate change and may have been interpreted as currently spoken about anthropogenic climate change or in the sense of recognising Earth's long history of a changing climate.

Similarly, of teacher participants interviewed all believed the climate was currently changing. Most of the teachers interviewed believed that humans played at least some role in the current changing climate. Many stated that they believe the climate is changing due to equal or almost equal parts natural occurrences or cycles, and human contributions or activities:

> *Currently I would say 50/50 between nature and man. I think the planet goes through cycles which some of its nature caused some of its manmade caused. It's probably 50/50 at the moment [M, 35-44, NS, P]*
>
> *Probably about the middle… there certainly are cycles however there's a whole variety of explanations as to why. There's no question it is getting warmer, you know it's not 10 degrees warmer, it's only, it's a small amount, like half a degree or a quarter of a degree or something [M, 45-54, S H6].*

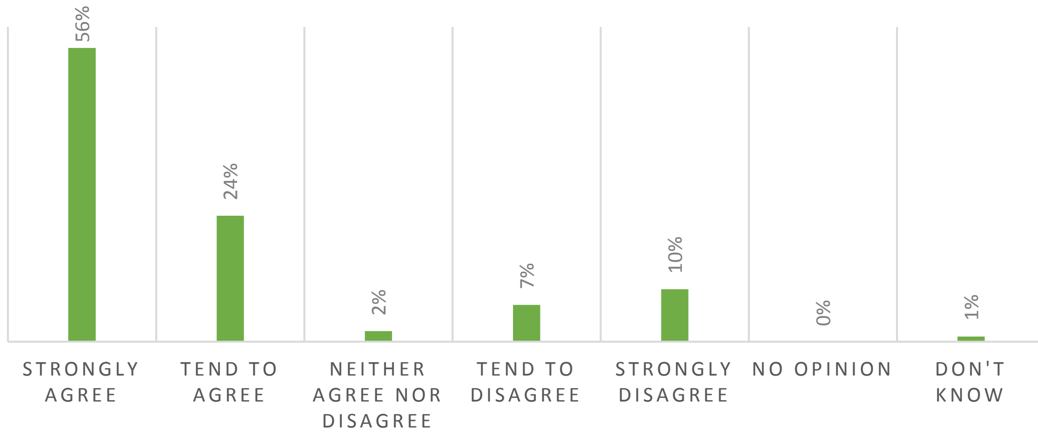


Figure 4.15. I am certain climate change is really happening (*n*= 309).

A high number of teacher participants interviewed expressed they believed that human contributions played a significant role in changing the climate:

> *I think it's not a belief so much it's what I've looked at with this it's yes, it's very obvious the data is there that climate change is happening. We are seeing some long term trends, um my logic says that with the amount of carbon dioxide that we are putting into the atmosphere and what I've seen of the data, there is virtually no doubt that the human interaction is definitely contributing to it… I'd say significantly [M, 55-64, S, H5].*

> *I believe that it's probably a big percentage. Um due to human actions because, because of, of the factories the greenhouse gas emissions. The, just you know, the exhaust fumes from our cars and everything we do. And we're just using too much energy and the bi-product [sic] of that is causing the problem that is creating the greenhouse effect, apparently [F, 65+, NS, T1].*

These findings were also reflected in the survey responses. The vast majority of respondents stated they believed "climate change is partly caused by natural processes and partly caused by human activities" (39%) or that "climate change is mostly caused by human activities” (37%) (see Figure 4.16). No significant differences were found for opinions on the causes of climate change based on gender, subject taught, primary or high school teaching focus or age ($p>.05$).

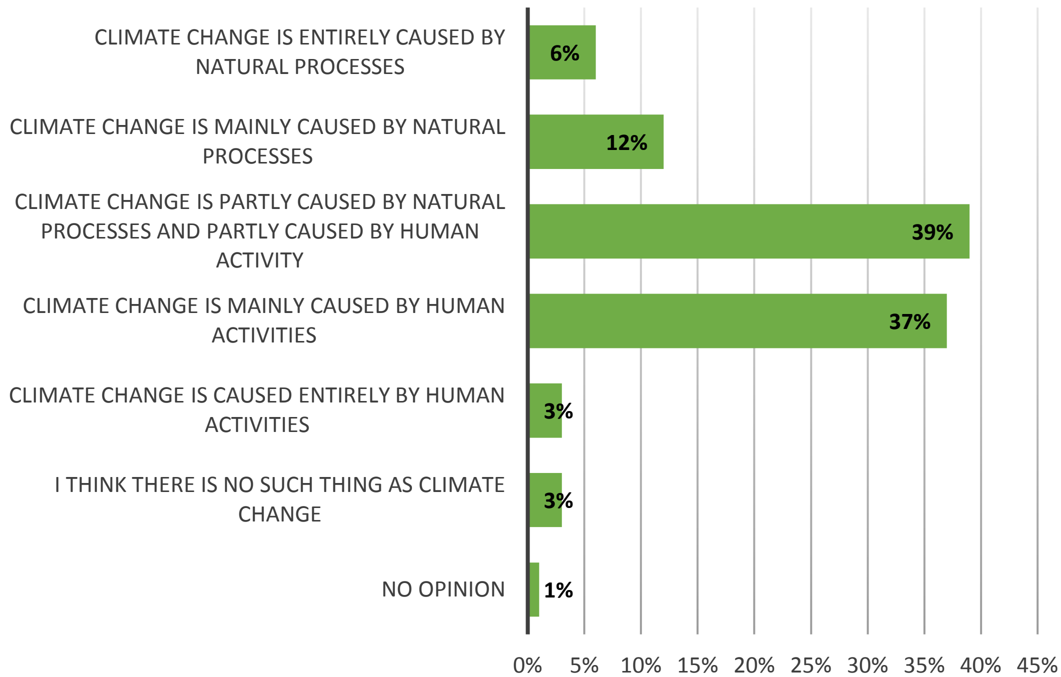


Figure 4.16. Thinking about climate change, which, if any, of the following best describes your opinion?

This belief in the occurrence of climate change and human influence is also reflected in the Australian study conducted by Reser et al. (2012). A number of other questions sought to gain an insight into teachers’ beliefs about climate change. Participants were asked to indicate their level of agreement (6) or disagreement (1) with the following statement ‘Human beings are responsible for global warming and climate change’. The majority (62%) of respondents chose five (5) (30%) or Strongly agree (6) (32%) (See Figure 4.17). Additionally, the majority

(72%) of survey participants either strongly (37%) or tended to agree (35%) that most scientists believe humans are causing the climate to change (see Figure 4.18).

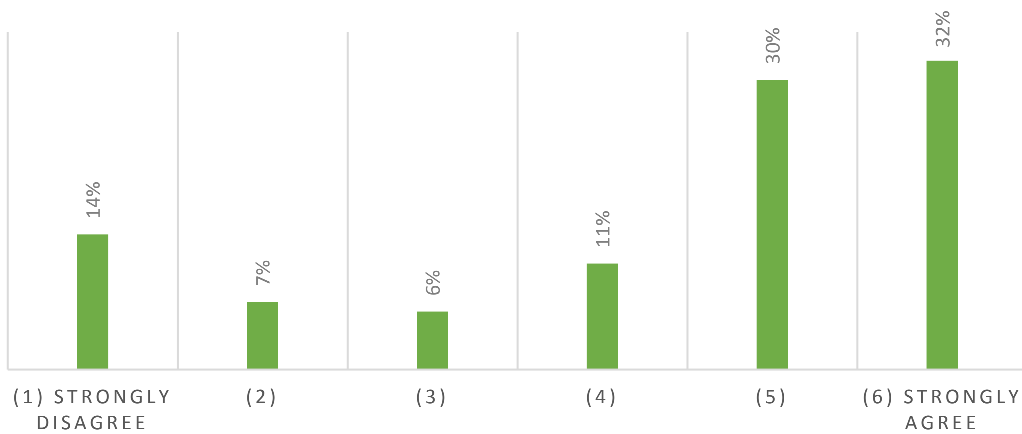


Figure 4.17. Human beings are responsible for global warming and climate change.

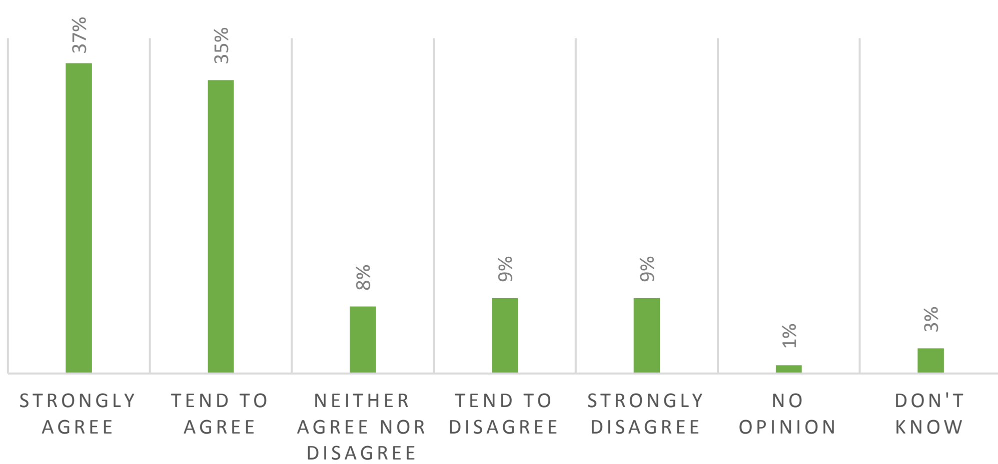


Figure 4.18. Most scientists agree that humans are causing climate change

The overall tone of those interviewed was that of confusion or uncertainty relating to the causes of climate change. When discussing the causes of climate change and human contribution some interview participants expressed a general sense of uncertainty about the issue. A number of interviewed teachers became hesitant or tentative when discussing what they believed to be the causes of climate change. One teacher, for example, when asked about human contributions to climate change responded:

> *Gosh, um, there's a suggestion that this is something of a natural phenomenon but I think that we're certainly accelerating it. The loss of the ozone layer and more light coming through and that whole thing that once you reduce the polar caps to certain um size you don't get that reflection effect any more instead you get the, the dark colour of the ocean actually drawing more heat in and it upsets the whole thing. So um, I do think that um, probably hovering about a 5 or 6* [on a scale of 1-10]*, it's somewhere in the middle, but I'm not sure where the responsibility lies. Look I definitely think we are aggravating it there are no two ways about it [F, 35-44, NS, H1].*

This participant's response highlights the general sense of confusion and uncertainty held by a number of teachers about the causes of climate change and the hesitancy to state their beliefs about the issue. Many teachers emphasised they were not sure of their response and highlighted their responses were opinions only or what they themselves *believe* rather than what they could claim to be substantiated facts. Participants frequently used words like "I believe" or "I think" when discussing these issues, emphasising the tentative nature of their comments. In this way teachers were, either consciously or not, speaking of climate change in terms of personal feelings about the issue rather than a considered evaluation of scientific evidence or claims. Science teachers were more likely to speak in terms of scientific evidence, however this was not universal.

Only one interview participant believed the causes for change were entirely natural occurrences. The participant, a high school science teacher, stated that scientists claiming climate change was occurring due to human influences were not necessarily lying but just wrong in their findings. Later the participant clarified that scientists and governments have an agenda which, in a lot of cases, was to justify their own existence:

> *Those jobs didn't exist 20 years ago [M, 45-54, S, H3].*

When specifically asked if he trusted the IPCC and their reporting on climate change, for example, the participant responded:

> *They have an agenda to keep propagating the information that allows them to exist [M, 45-54, S, H3].*

The participant also felt that although historically climate change has resulted in severe consequences and that current climate change could possibly result in negative consequences, there was no need to adapt at this point. This individual noted he had purchased books on climate change such as those written by Ian Plimer, Ian Wishhart and Garth Paltridge, all of whom are sceptical of anthropogenic climate change.

4.3.2 Consequences

Concepts of potential consequences of climate change were also explored. Most participants responded to the question of consequences in terms of global and national future human consequences rather than in immediate, local, ecological or personal terms. Future sea level rise was most commonly identified as a consequence of climate change. Sea level rise was linked to lower real estate prices, food security, and migration:

> *Well in the, if we just look at the next 100 years like to the end of this century let's say, I think if they are saying a metre sea level rise, that's going to have fairly terrible effects in some of the low lying areas, Bangladesh, Indonesia. When we think of the refugee or the supposed refugee crisis we have now, I mean that's nothing compared to what we will have if the seas are a metre higher [F, 55-64, S, H2].*

Threatened global food security was mentioned as a possible future consequence of climate change by a number of teacher respondents, these threats were often related to water availability:

> *Well I think it is possible what it will do is that it will make agriculture more difficult, it will make water more difficult. I think it will make living on the planet more difficult [M, 55-64, NS, H1)*

> *Well the main things I think we are going to see is increased uncertainty with water supplies and with food supplies, on a worldwide basis [M, 55-64, S, H5].*

An increase in extreme weather events, as well as threats to wildlife were mentioned by a smaller number of respondents:

> *Well I think some places will end up with perhaps more rain… some will end up much, much drier and actually be incapable of being lived in and be in use for the purposes that we use them at the moment. I think there will be changes in the weather as such that cyclones, for example, will cause people to not be able to live along the coast in the same ways that they do and I think we'll see people trying to move inland but then if the weather is not able to support that then I think it will be difficult [F, 45-54, S, H4].*

> *So you know, there will be effects on animals their habitats will change and they will either, well they won't survive in the short term, but you know, evolution will cope with that eventually [F, 55-64, NS, P3].*

When asked directly if climate change would affect the teacher participants personally some stated no, citing their age or the location in which they live as reasons they will not be affected:

> *No I'll be dead [F, 55-64, NS, P3].*

Um, impact on me personally. Obviously it won't affect me personally I live on the top of a hill. Look, I think it will affect food crops that will have an effect on me. I think it will affect communities, which may have an effect on me. Ah, but me personally no [M, 35-44, NS, P2].

When prompted to consider if climate change will affect them personally, some participants responded that climate change was already affecting them in some way. Instances of changing or extreme weather (e.g. Brisbane floods) were cited, as well as, financial burdens of carbon pricing, and housing decisions:

Yeah I dare say so. I'll.., Brisbane floods a couple of years ago I was. So yeah I suspect so. It might cause me to live in different parts of the country [M, 55-64, S, PH1].

Well financially I think it's impacting on me already. The um, the cost of carbon in the market place has a flow on effect to me. The cost of carbon emissions in the market place has an effect on me, and I take it to heart that the loss of habitat and loss of species that I think is connected to climate change. And I am a mother so I have a stake in the future generations and that also concerns me [F, 55-64, S, H3].

Um I think as we go through the cycles we will see the air temperature and the water temperature rising in the current cycle. I think it will have an effect on particularly marine life and uh I suppose animals and plants, with some species being killed off. It will affect the amount of freshwater that we have available. At the same time I think we will hit a point where the planet will correct itself and we'll head back in the opposite way in the cycle [M, 65-44, NS, P2].

These implications were not typically viewed by teachers as serious or of great concern to them personally.

One-way analysis of variance (ANOVA) were conducted to examine relationships between personal beliefs about the causes of climate change and beliefs about risk, seriousness and inevitability of climate change. A relationship was found between respondents' beliefs about the causes of climate change and their perceptions of risk caused by climate change to the Australian public, and this finding was significant ($F(2, 296) = 143.08, p=<.001$). Bonferroni post-hoc analyses revealed those respondents who believed climate change was mostly or entirely caused by natural processes were not surprisingly less likely to perceive future risks (M=3.84, SD=1.45) compared with those who stated they believed climate change was mostly or entirely caused by human activities (M=1.21, SD=0.41, p<.001).

A relationship was also found between respondents' beliefs about the seriousness of climate change at the present moment and their belief about the cause of climate change ($F(2, 295) = 186.92, p=<.001$). Bonferroni post-hoc analyses revealed those who believe climate change is mostly or entirely caused by natural processes perceiving climate change to be less serious (M= 2.16, SD=1.23) than those who believe climate change is mostly or entirely caused by human activities (M=5.43, SD=0.76, p<.001).

Beliefs about the inevitability of climate change were also found to be related to beliefs about cause ($F(2, 296) = 29.25, p=<.001$). Bonferroni post-hoc analyses revealed those respondents that believe climate change is caused mostly or entirely by natural processes were also significantly more likely to believe climate change was inevitable regardless of actions taken to mitigate human impact (M= 4.59, SD =1.68) compared with the respondents who believed climate change was cause mostly or entirely by human activities (M=2.79, SD= 1.47, p<.001).

This study suggests that teacher beliefs about the causes of climate change influence their perceptions of risk. The survey findings suggest participants who associated climate change with human causes were more likely to believe climate change was a serious issue and pose a risk to Australia. Conversely participants who believed climate change to be a natural process were more likely to believe climate change to be less serious and to pose lower risk. However, although other studies have highlighted differences in risk perceptions associated with gender and age (Stefanova, Connor, & O'Halloran, 2014), no relationship was found between gender or age and risk perceptions amongst the participants of this study.

4.4 Summary of findings

The remainder of this chapter presents a summary of the findings presented above. Overall the results indicate that most Queensland teachers in the study view climate change through a mixed lens. Many trust scientists to provide accurate information about climate change and believe that most scientists accept that humans are influencing our climate. Most Queensland teachers accept at least some human causal role in climate change and the majority view climate change as a high risk to places and people, including Australia and Australians. However these beliefs are combined with doubt, confusion and mistrust as teachers report being unsure of the scientific position on climate change and question the reliability of government and the media as sources of information. Although many do not trust the media as a source of reliable information about climate change, teachers predominantly access information about climate change through the media. The majority feel pessimistic about the extent to which individual actions can limit climate change but less so about government interventions.

Key points from the findings are summarised below:

Teachers' understandings of climate change.

Teachers:

- are aware of climate change and feel they know something about the issue
- who are male, teachers over the age of 55 and science teachers were significantly more likely to believe they know something about the issue
- predominantly think about climate change in current, anthropocentric terms, however these terms are limited to causes and a small number of consequences that are not immediate or local
- are more knowledgeable than the general public about climate change

- hold a general understanding of the causes and consequences of climate change and most commonly discuss causes in anthropogenic terms
- believe that scientists agree that humans are changing the climate
- surveyed indicated they believed climate change posed some risk to people in Australia
- are not overly optimistic about a concerted global mitigative response to climate change
- are supportive of individual actions and believe they can be effective, however are not confident enough individuals will take action on their own
- are not thinking about responses to climate change in terms of adaptation
- of science appear to be no different from non-science teachers in their climate change science knowledge

Sources of information teachers use to inform themselves about climate change.

Teachers:

- in general, do not actively seek information about climate change
- mostly engage with climate change information through news media
- mostly use the internet or 'Google' when looking for information on climate change
- do not trust newspapers and radio as accurate sources of information
- generally trust scientists for information about the environment

Personal beliefs about the causes and consequences of climate change.

Teachers:

- believe the climate is changing
- believe that climate change is caused by humans either entirely (3%), mainly (37%) or a combination of human contributions and natural influences (39%)
- view the consequences of climate change in abstract or distant terms

- who recognised personal impacts of climate change did not view them as overly troubling
- who view climate change as human caused are more likely to view climate change as a risk
- who believe climate change to be predominantly caused by natural processes were more likely to view climate change as inevitable

4.5 Chapter summary

This chapter reported the findings from the online survey (*n=329*) made available to registered teachers in Queensland, Australia and follow-up interviews with 21 teachers. Findings presented here are related to questions specifically focussed on teachers' beliefs, knowledges and understandings of climate change. The following chapter, chapter five, will present findings related to teachers' beliefs about climate change education.

Chapter Five
Research Findings and Analysis
Climate Change Education

5.0 Introduction

Chapter four presented data relating to the first set of sub-research questions focussed on teachers' understandings of climate change, as well as information sources used by teachers to inform themselves about the issue. This chapter reports data, from the online survey and 21 teacher interviews, related to the second set of four sub-research questions focussed on teachers' beliefs and reported practices in relation to climate change education: (1) What does climate change education mean to teachers? (2) What are the beliefs of teachers about the need for and appropriateness of climate change education? (3) What do teachers report as influencing their decision to include or exclude climate change in their curriculum? (4) What do teachers report as their classroom practice in relation to climate change?

The open ended survey responses will be identified in the following text by: *M/F* (male/female), *age*, *S/NS* (science/non-science teacher), *P/H/T* (primary/ high school/tertiary teacher).

5.1 What does climate change education mean to teachers?

Evidence from this study supports suggestions within the literature that climate change education has tended to focus heavily on increasing individuals' understandings of climate change in the form of science education (Anderson, 2012; Kagawa & Selby, 2010), with few formal curricula engaging with the wider implications. Interview and survey data indicate the most commonly emphasised dimension of climate change education by teachers was climate science education.

Interviewed teachers were asked what climate change education is or what climate change education means to them. Participants were not provided any criteria or guidelines of what may be included within the concept of 'climate change education' and as such responses to this question rely on a teacher's own interpretation of what climate change education may include. Science was emphasised as central to climate change education. All responses included reference to science or more directly, understanding of the Earth's climate system:

> *Well it would need to cover palaeontology and geology and plate tectonics and probably a history of it from the beginning and what caused, what we know caused those changes in climate, and what their effects were [F, 55-64, NS, P3].*
>
> *Probably looking from a global systems point of view, looking at the four systems and the reaction of the systems, I think of, from a chemistry point of view the different gases that's involved and from a physics point of view I think about the energy point, from the energy levels and energy absorptions and things like that. I think about all those things and then I guess less the effects on the social, but probably I'd do it from a more scientific point of view [F, 45-54, S, H4].*

Survey respondents were also asked to describe what climate change education involves in their own words. This question was presented in an open-ended response format, in which respondents could also choose not to respond and skip the question. In line with interview participants, survey respondents were not provided any criteria or guidelines of what the concept of 'climate change education' included, but were left to decide for themselves what climate change education may involve.

Teachers within the survey referred to the need to explore historical climate changes, the causes of past climate change and the consequences of those changes. Students developing an understanding that climate change has happened in the past with various factors influencing these changes was viewed as important by teachers:

> *A comprehensive study of how our earth's climate has changed through time due to various causes [M, 35-44, NS, H].*

Raising the awareness of the complex interactions as evidenced by past geological, continental, solar and climatic processes to give an indication of what has happened in our close and distant history and what is possible in the future [M, 45-54, T].

As well as an understanding of the causes of historical climate change, teachers stated climate change education also involves an understanding of the current causes of climate change including both anthropogenic and naturally occurring influences:

Making students aware of the factors that contribute to natural & man-made climate change and how past events in geological history and recent human history [M, 55-64, S, H].

Awareness of current global climatic conditions and possible, plausible reasons for any discovered variances or remarkable changes over the past few decades / centuries [F, 55-64, NS, H].

A specific emphasis on the anthropogenic causes of current climate change was the focus of a smaller number (less than 10%) of respondents:

Understanding the Earth's climate and its processes including that of the past. Understanding what climate change is and what contributes to it (including the role humans are playing) [F, 25-64, NS, P].

Educating students about the science and long-term statistics of weather and climate change, and how humans are currently having an impact in relation to the over-use of resources on the planet [M, 35-44, S, H].

Teachers' conceptions of climate change education as climate science education appear to be limited. Many teachers articulated an understanding of climate change science education that covered limited scientific concepts, most notably understandings of atmospheric compositions, particularly greenhouse gases, an emphasis on the causes of climate change, both historically and in current scientific terms, and temperature increases. As such, while the focus of climate change education is limited to science education, it is further limited in terms of what elements of climate change science are covered. Climate change education was seen primarily as a means for students to assess scientific information relating to the occurrence and causes of climate change.

The second most referenced theme during interviews was the concept of balance. Teachers frequently expressed that climate change education should be presented from a 'balanced' point of view, or one that explores all 'sides of the argument' in an impartial way that does not privilege one point of view over another:

> *It would need to be one that's balanced… balanced in the providing of a range of scientific data where it's not – climate change is happening, it's caused by humans for these reasons. I don't want to see that sort of information; I'd only want to see introduced into classrooms resources which particularly encourage kids to think that way. I think we need to encourage kids in science to think in an open-minded manner [M, 55-64, S, H5].*

> *Umm.. climate change and education, probably how to teach it in a balanced way, present it as a balanced point of view, is my initial thought [M, 35-44, NS, P2].*

In line with interview participants, the idea of balance and presenting students with 'both sides of the climate change argument' or a balanced perspective was also identified by survey respondents as climate change education. Teachers identified that there existed a 'for and against' argument or more than one side to climate change that students should be made aware of:

> *Balanced view of the knowledge base (science) around the topic (both for and against) [F, 45-54, S, H].*

Not telling students what to believe but allowing students to review or be given all ‘sides’ of the argument so they were able to ‘make up their own mind’ about climate change was considered important by teachers. Respondents expressed the belief that what a teacher believes about a topic should not be ‘forced upon’ students. Further emphasising that teachers believe there are at least two equally as valid ‘sides’ involved in a debate about (anthropogenic) climate change:

> *Both sides of the argument should be taught and teacher's opinions should not be put onto the students [F, 45-54, NS, P].*

Respondents indicated teachers should facilitate student access to the many different viewpoints on climate change and sources of information and then allow students to use that information to form their own opinions:

> *Allowing children to hear a variety of information from a variety of sources and allowing them to draw their own conclusions and not force the answers from mainstream media to be the only ones [F, 25-34, NS, P].*
>
> *Making students aware of the issue (both for and against) - and presenting the science and allowing them to make critical judgements based on* data *[F, 35-44, S, H].*

The data suggest teachers view climate change as an open issue (Hess, 2009), or as an issue where multiple people disagree and there is insufficient evidence to settle the differences of opinion (Stradling, 1985). As such, teachers are suggesting there are multiple, competing, legitimate perspectives on the occurrence and causes of climate change and these perspectives should be heard by students in a balanced, unbiased way. Teachers view their role as neutral facilitators, providers of information with which students can assess and determine their own views and as such contend that climate change education should be approached in an impartial way that does not privilege one position on the issue over another. This is despite the evidence that 97% of published scientific research on climate change support the theory of anthropogenic (human influenced) climate change (Cook et al, 2016).

Although climate change science is not controversial, climate change is a controversial issue within the wider community. While balance or neutral impartiality was the preferred approach of many educators (Hess, 2005; Kelly, 1986; Stradling, 1985), there are a number of different ways teachers may approach controversial issues, these include avoiding an issue deemed controversial (exclusive impartiality) or privileging one particular view over another (exclusive partiality) (Hess, 2005; Kelly, 1986; Stradling, 1985). The majority of teachers within this study acknowledged the wider political and community controversy surrounding climate change and no teacher believed it wise to ignore this controversy.

At the same time as believing it important to provide a balanced account of the issue, a number of teachers acknowledged the difficulty of a completely impartial neutral stance on any issue (Oulton, Day, Dillon, & Grace, 2004). These teachers felt they should approach climate change in a committed impartial way (Kelly, 1986). In this way teachers may not hide their own opinions from students, however at the same time they believed that competing views should receive a fair hearing. These teachers suggested that although it may not be possible to maintain a completely neutral stance, particularly if they held strong beliefs, they believed intentionally privileging one point of view over another would be consistent with indoctrination, which all teachers were against.

Holding a strong opinion about the subject matter may lead to some teachers avoiding the issue altogether. One surveyed teacher, for example, indicated she avoided teaching climate change with her students due to her strong opinion on the issue and her lack of desire to be ridiculed:

> *Due to my personal viewpoint I have avoided the topic as I don't like to be told that I am wrong about a theory by a bunch of 12 year olds [F, 25-34, NS, P].*

However, this position was in the minority with others stating their strong opinions served as a motivator to address the issue.

Exclusive partiality was the preferred approach of a small number of science teachers. These teachers indicated they would not teach students that climate change science was controversial within a scientific sense. These teachers stated they would privilege the current accepted science as 'truth', while acknowledging the wider community controversy. These teachers were typically knowledgeable about climate change science and wholly accepting of the scientific position. Importantly, these teachers, as with all teachers in this study, believed it was never appropriate to coerce or persuade students to take a particular point of view on climate change or on any topic.

Despite the complexity of climate science, only a small number of teachers identified that students may not have the decision making or technical skills required to 'make up their own minds'. These teachers noted the need to develop skills within their students to help enable the decision making process:

> *Giving students the whole perspective, both for and against, and providing them with the skills in order to formulate their own ideas and develop strategies in accordance with their ideas [M, 35-44, NS, H].*
>
> *Teaching students how to sift through the information available and make their own decisions on the validity of the arguments on both sides [F, 55-64, NS, H].*
>
> *Our job is not to tell the students what opinion to have but more so it is to equip them with the skills to inform their own [F, 35-44, NS, H].*

This does not necessarily indicate teachers would not provide guidance, however it appears the primary focus for teachers is for students to make a decision about which side of the climate change debate to choose, rather than developing scientific literacy using the context of climate change and the perceived debate. Many teachers in this study believe climate change education is important as the topic is relevant to student lives and is an issue students ought to know something about. In this way, the teachers in this study approach climate change education from a topic-based rationale (Stradling, 1985), where the topic itself is seen as significant and should be understood by students.

A small number (less than 10%) of respondents maintained anthropogenic climate change was not occurring. Respondents who commented in this way typically viewed anthropogenic climate change as being fictitious:

> *It is a natural process that the world's climates change. Global warming died a natural death! [F, 55-64, NS, P].*

> *Over the centuries climate changes have happened and gone through different cycles. The climate now [sic] has happened many times through the ages and will again [F, 55-64, NS, P].*

In some cases these respondents questioned the necessity of climate change education as well as the motivations of those supporting climate change education:

> *Climate change 'education' is actually climate change brainwashing. Those who teach it speak balderdash and twaddle e.g. Australia is running out of trees and China is a very environmentally friendly country [F, 45-54, NS, P].*

> *The teaching of unsubstantiated beliefs to children who do not possess the necessary core knowledge to think critically about an unresolved study.*

> *Biased Government agenda [M, 55-64, NS, P].*

> *Ignoring junk science used by snake oil pseudo "scientists" to justify their exhorbitant [sic] salaries [M, 55-64, S, H].*

Others with a sceptical point of view saw climate change education as a means of addressing what they saw as misinformation. The misinformation was often linked to political agendas or biased media reporting:

Teaching the truth. I [sic] at the moment it is very biased towards political agendas. Climates change - anyone with minor knowledge of ecosystems know they do not ever stay the same hence we continually see a change in the Earth and its organisms over periods of time [M, 35-44, S, H].

It should expose students to both sides of the argument, not just what the scientists chasing funding and the media want to push. Both sides of the argument are not given fair voice in today's world [F, 45-54, NS, P].

Balanced approach that demonstrates it is just a media and politically funded theory that has very little scientific accuracy [M, 65 or over, NS, P].

Media-proofing students so they do not accept the rubbish coming through the media and idiots/ hypocrits [sic] like Al Gore [M, 55-64, S, H].

The survey suggests many teachers believe all teachers should be engaging with climate change education. Fifty-seven percent of survey respondents either strongly (21%) or tended (36%) to agree that climate change education is the role of all teachers (see Figure 5.1).

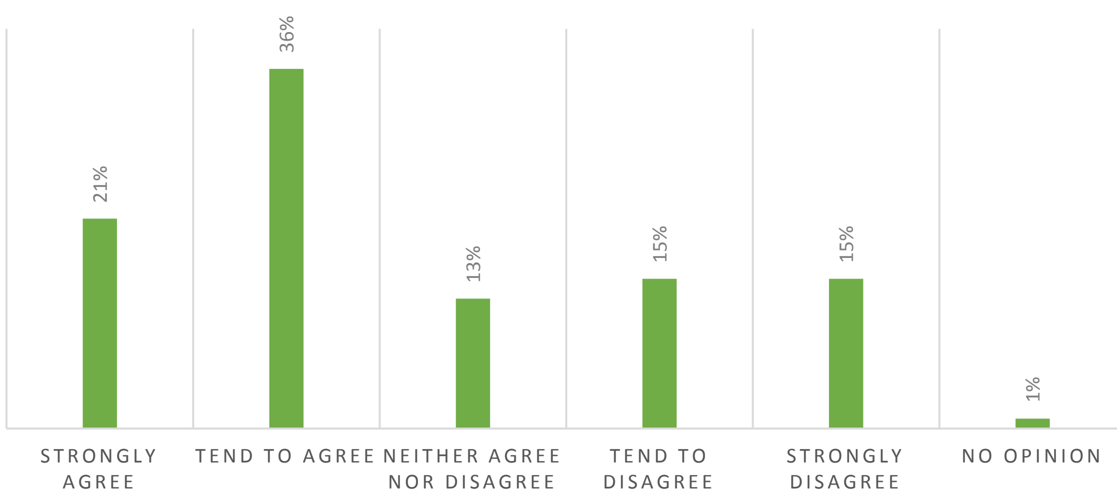


Figure 5.1. I believe climate change education is the role of all teachers (*n=306*).

In somewhat of a contrast to interview and survey respondents' focus on climate change education as science education, survey respondents indicated they did not agree that climate change education is the sole duty of science teachers. A large majority (78%) either strongly disagreed (44%) or tended to disagree (34%) with the statement: *Climate change education is solely the responsibility of science teachers* (see Figure 5.2).

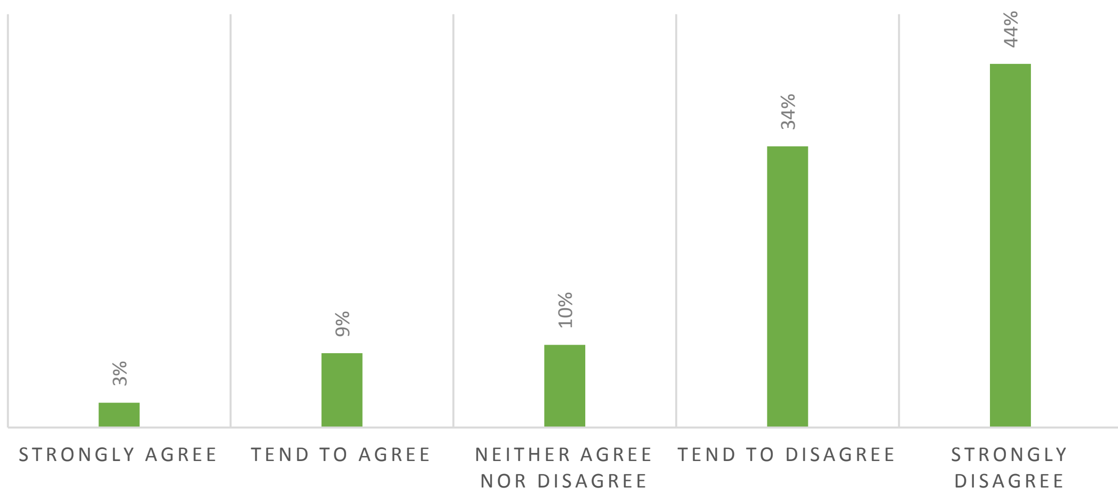


Figure 5.2. Climate change education is solely the responsibility of science teachers (*n=304*).

The survey included a number of Likert items asking teachers to indicate the level of agreement they felt with a number of statements about climate change education. As indicated above, survey and interview participants identified climate change science education as climate change education, yet the majority (59%) of survey respondents either strongly disagreed (23%) or tended to disagree (36%) with the statement *climate change education means solely teaching students about the science of climate change*. However, in somewhat of a contradiction to this, the majority of respondents (63%) either strongly agreed (28%) or tended to agree (35%) with the statement *climate change education should primarily focus on scientific understandings* (see Table 5.1).

Table 5.1

To what extent do teachers agree or disagree with the following statements?

	Strongly agree	Tend to agree	Neither agree nor disagree	Tend to disagree	Strongly disagree	No opinion	Don't know
Only 'one side' of climate change (that it is happening and humans are the cause) should be taught to students.	4%	8%	9%	**24%**	**46%**	4%	5%
Climate change education should make students aware of the controversy surrounding climate change.	**47%**	**41%**	7%	2%	3%	1%	0%
Climate change education should include both sides of the debate equally.	**33%**	**27%**	10%	15%	13%	1%	1%
Climate change education should primarily focus on scientific understandings.	**28%**	**35%**	16%	14%	4%	2%	0%
Climate change education should be focussed on how to stop or slow down climate change.	**21%**	**38%**	16%	10%	13%	1%	2%
Adaptation to climate change is an important element of climate change education.	**29%**	**40%**	15%	5%	9%	1%	1%
Climate change education includes encouraging students to be critical thinkers and problem solvers.	**66%**	**26%**	3%	1%	3%	0%	0%
Climate change education should aim to change the way people behave.	**34%**	**39%**	12%	7%	6%	2%	0%
Climate change education should encourage students to think about their own beliefs and values.	**48%**	**39%**	7%	3%	3%	0%	0%
Climate change education involves many complex issues including human rights and social justice.	**31%**	**40%**	10%	9%	8%	1%	1%
Climate change education involves student understanding how the use of CFC's has damaged our climate.	10%	**42%**	15%	**17%**	13%	1%	1%
Climate change education means solely teaching students about the science of climate change.	6%	19%	13%	**36%**	**23%**	1%	2%

The teachers surveyed believed that the controversy surrounding climate change was something that should not be ignored. A high majority of respondents (88%) either strongly agreed (47%) or tended to agree (41%) that climate change education should make students aware of the controversy surrounding climate change (see Table 5.1). Many (70%) also strongly disagreed (46%) or tended to disagree (24%) with the statement that *only one side of climate change (that it is happening and humans are the cause) should be taught to students* (see Table 5.1). This finding underlines previously reported findings revealing teachers identify a preference for a balanced approach to the topic of climate change which allows students to make up their own minds.

Encouraging students to be critical thinkers and problem solvers was also seen by a large majority (92%) of those surveyed as part of climate change education, 66% strongly and 26% tended to agree with this statement (see Table 5.1). This sentiment was also reflected in responses from survey respondents in the open answer field, however critical thinking and problem solving were limited to deciding which side of the 'debate' students believed and not extended beyond the 'science information debate' frame:

> *Teaching children that scientific issues have many facets and information should be critically analysed. All 'players' have their own agendas and unfortunately the message the scientists want to share may not be the one the media and government disseminate [F, 35-44, NS, P].*

> *Climate change education should involve critical thinking about the science on both sides of the debate and about the influence of media and government in the scientific information available and promoted [F, 35-44, T].*

5.2 What are the beliefs of teachers about the need for and appropriateness of climate change education?

All interviewed teachers believed that climate change education is appropriate and necessary.

> *Oh without a doubt. We all live on the Earth [F, 35-44, NS, H1].*

Survey respondents overwhelmingly believed that climate change education was appropriate for school classrooms. A large majority of respondents (87%) either strongly disagreed (68%) or tended to disagree (19%) with the statement; *climate change education is too controversial to be discussed in classrooms* (see Figure 5.3*).*

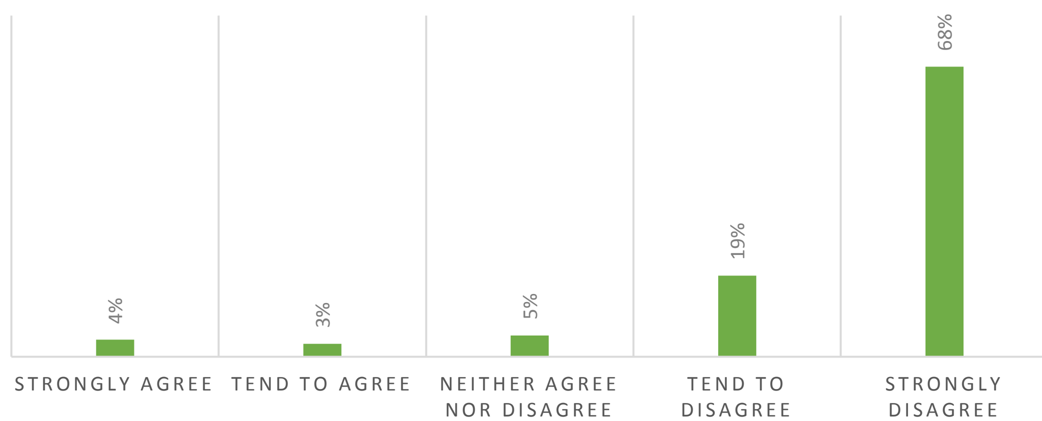


Figure 5.3. Climate change education is too controversial to be discussed in classrooms (*n*= *305*).

The majority of respondents either strongly disagreed (58%) or tended to disagree (24%) with the statement: *It is not the role of schools to teach students about climate change* (see Figure 5.4). Further, when asked to indicate their level of agreement with the statement*: Climate change education is not appropriate for schools*, the majority of respondents either strongly disagreed (65%) or tended to disagree (17%) with this statement (see Figure 5.5).

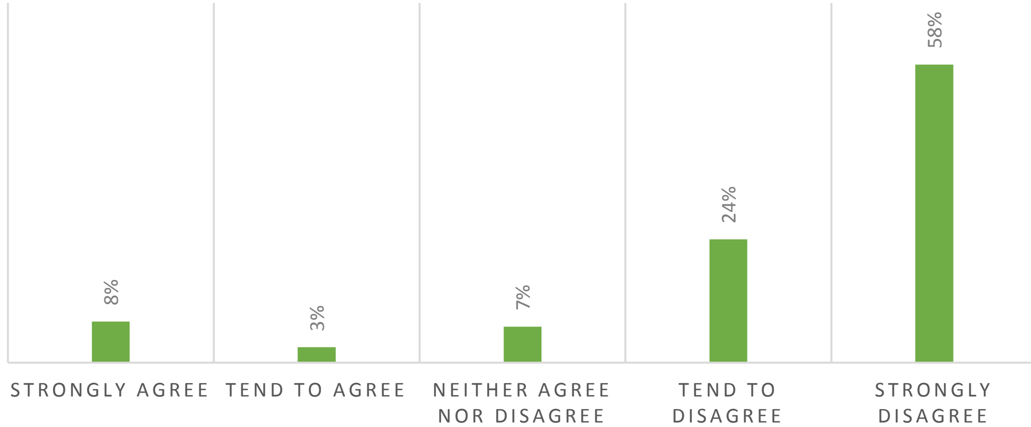


Figure 5.4. It is not the role of schools to teach students about climate change (*n=305*).

These findings support research suggesting teachers' value education that allows students to benefit from learning the concepts, knowledge, skills and values associated with sustainability education and believe it is important to personally integrate sustainability into their own teaching practice (AESA, 2014).

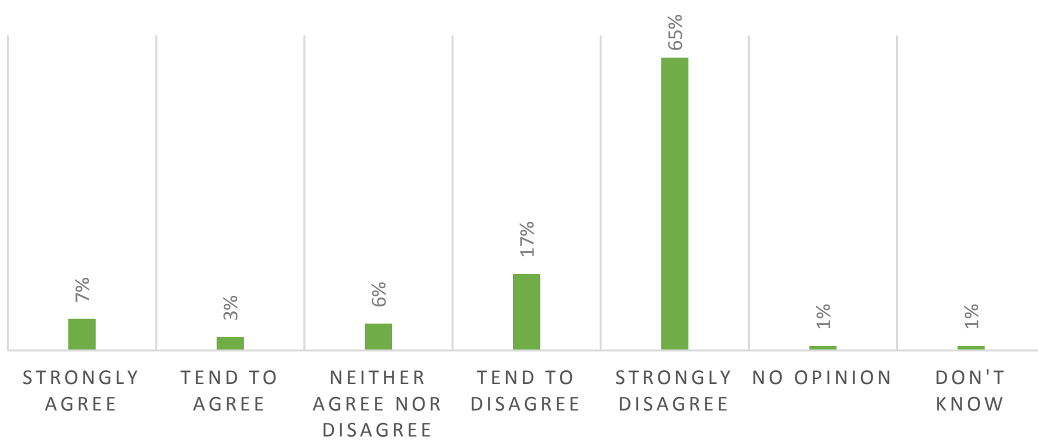


Figure 5.5. Climate change education is not appropriate for schools *(*n=*308).*

Teachers also indicated through survey responses that informing students of their own personal impact and individual actions that students can take to help reduce their impact on the Earth was important:

> *Making students aware of how their actions impact on the worlds [sic] climate and then showing them ways to lower their impact on the world's climate [F, 45-54, NS, P].*

> *Helping students understand their part in contributing to the health or otherwise of the planet and to take individual responsibility over their actions [F, 45-54, T].*

Teachers also felt climate change education provided an opportunity to engage with world issues within their classrooms (see Figure 5.6).

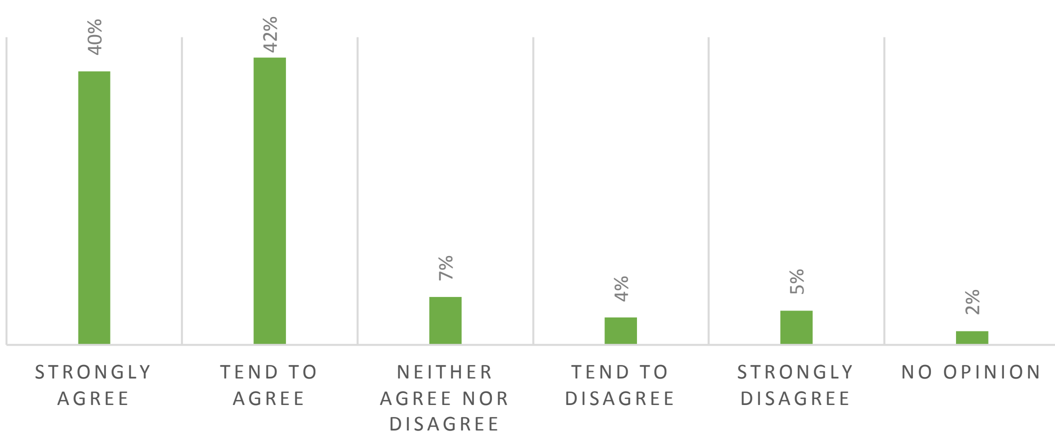


Figure 5.6. Climate change education provides an opportunity to discuss world issues with my class (*n=306*).

On the other hand, many teachers believe the complexities of climate change science should not be explored until high school, with all interviewed teachers emphasising the need to consider the age appropriateness of the curriculum. Some participants believed climate change education was inappropriate for younger students, emphasising high school as an appropriate age to introduce the topic. Exploring this idea further, teachers were asked to clarify their positions; many believed introducing scientific concepts relating to climate was inappropriate in younger years, however climate related topics were viewed as appropriate including differences between climate and local weather events for example. High school was typically viewed as a more suitable age for climate change education due to the scientific complexity of the issue and student thinking and reasoning skills:

> *You've got to have some reasoning and that takes longer to get. We used to, for example, you don't teach genetics in year 9. I have, we used to teach genetics in year 9 but kids don't get anywhere near as much out of it as they do in year 10. They can think more, or the logic processes and so forth takes longer, reasoning takes longer to develop [M, 45-54, S, H6].*
>
> *I think I'd say it's probably a middle to upper thing. For the little ones I mean what does change really mean to them? They don't have the experience. They could be learning the basic science behind what is climate within the younger years and then examining whether there's been a change in the upper years. I'm talking primary school now, so middle school to high school you could look at the change but I don't think that little ones are capable of examining climate change as such [F, 35-44, NS, P1].*

Teachers feel younger years should focus less on scientific details, while still developing the fundamental skills necessary to be able to engage with the science of climate change when they reach high school. This idea stems from the foundational belief that climate change education is science education and the view that climate change science education involves allowing students to view and assess scientific evidence to make up their own minds.

Participants also believed it was inappropriate to be teaching students the more 'extreme' issues relating to climate change including security issues and mass extinction. Climate change education that delivers a message of hopelessness or doom was also seen to be inappropriate:

> *I don't think it is appropriate to be teaching, or conveying in teaching, an attitude that we're up the creek without a paddle. I think that it is important to convey the fact that we can have some influence on climate change and that it is important that we choose to do that [M, 45-54, NS, P1].*

> *Well you wouldn't stress the wiping out of every species on the earth including people. I wouldn't be stressing that [F, 55-64, NS, P3].*

> *I think it's really, really important that you don't give adolescents or children [the idea] that it's all pointless because it is all going to go to rack and ruin. They can be very emotional creatures and they can become very depressed very easily about the littlest of things, so to suggest to them that our entire world is going to change and collapse and fall to pieces because of things humans are doing is just cruel. I think that it is really important that they understand that the climate changes and what humans do can affect the change in climate but it is really important that what they are taught is balanced [F, 55-64, S, H2].*

The participants indicated positive outcomes and messages of hope for the future were important. Providing opportunities for students to recognise that individuals and communities can make a difference was essential to teachers:

> *I think that's important that when you teach it that you provide a solution that you don't go this is all doom and gloom, you might say things like this is all doom and gloom unless we do something about it. We've got a bit of time on our side it's not over yet [M, 45-55, S, H6].*

> *I match abilities but I present it as an opportunity for change, and I try to spark that interest in them. You know you're ten look at your lives but in another 10 years, which is the same time period that they have been here, they could be running the show. How exciting is that? And I try to get them*

motivated and excited about the potential for who they can become and what they can do [F, 35-44, NS, P1].

Recent studies have argued hope can both positively and negatively affect engagement with environmental issues including climate change. Hope based on denial of the seriousness of climate change was shown to have a negative effect on environmental engagement, while hope based on confidence in the ability to create a preferred future and the competency of others was a positive motivating force (Ojala, 2012, 2015). The teachers in this study did not advocate avoiding the issues or challenges climate change poses, with the exception of the more extreme possible consequences. Teachers stressed the need to ensure students felt there was something that could be done in the face of climate change.

The teachers reported they have not witnessed hopelessness or despair in the children that they teach:

I haven't chiefly because, regrettably, it tends to still be an issue that is not very well known or understood by students [M, 45-54, NS, P1].

No, it's probably got more to do with the kids, they sort of feel almost insulated from things like that, that's too bigger problem, somebody else will deal with that [M, 55-64, SM, H5].

In contrast, many reported that in most cases the students that they have interacted with overwhelmingly display a sense of apathy or casual disinterest. A number of teachers indicated they felt students were uninterested in many things:

I'm loath to admit it. But kids these days couldn't care less. They want to have all their technology, their mobile phones and that sort of stuff, they're born to consume [M, 45-54, S, H4].

Another explanation for the apparent lack of interest in climate change shown by the students of the participants in this study may be a maladaptive response to the overwhelming threat climate change poses. Psychic numbing or apathy in individuals can be a response to perceived overwhelming environmental threats (Moser, 2007). One teacher spoke of the sense of powerlessness she senses students must feel and the ways in which she tries to empower students:

> *…no. I don't think it's that they don't care I think that it feels so hopeless to try and change anything. It is such a big thing... The ramifications are enormous, I couldn't even begin to tell you what they are and I think kids aren't stupid, they know that. So for me, my point is to try and teach them, show them how to find good information, make sure that they understand information. Give them a basic understanding of how to interpret that data and I tell them, it's changed in the last four years it will definitely change in the rest of their lifetimes… I feel pretty helpless about it, I can't even change anything in the school, I don't see how we can rely on the leaders to change something in, within our, within a huge country and then you get one country saying we're not changing because the rest of the world doesn't change. And you just think I get where they are coming from and kids would feel that as well, and they're even less able to change what happens at home, aren't they? If they're sitting on a bus that's got four other students on it and they have a whole big bus come and collect them. How un-empowering is that because they would think, why would I bother turning a light off in my bed room when the adults in this world are running huge buses to and fro with nobody on it? It's ridiculous. I can understand where they are coming from. But I suppose really in some ways that's why I don't tackle the social things because if I started to I'd become pretty depressed, and I think that kids are like that too. They protect themselves from what they know is dire, I mean they're not, I believe they're not stupid they hear stuff about the consequences but they have to not take or internalise that. I don't believe they don't care. I just believe they are*

protecting themselves from hearing a bit because it's something they feel powerless about [F, 44-55, S, H4]

This teacher questioned the ability for students to feel a sense of efficacy in their own personal actions or day to day lives when they appear to have so little influence or control of the events around them. No teacher discussed or appeared to recognise the need to provide a space for students to share their concerns or communicate their despair (Hicks, 2007; Selby & Kagawa, 2010).

5.3 What do teachers report as influencing their decision to include or exclude climate change in their curriculum?

Climate change education was seen as a priority (43%) or high priority (20%) for the majority (63%) of respondents to the survey. A small percentage of respondents (5%) believed climate change education had no place in their classroom (see Figure 5.7).

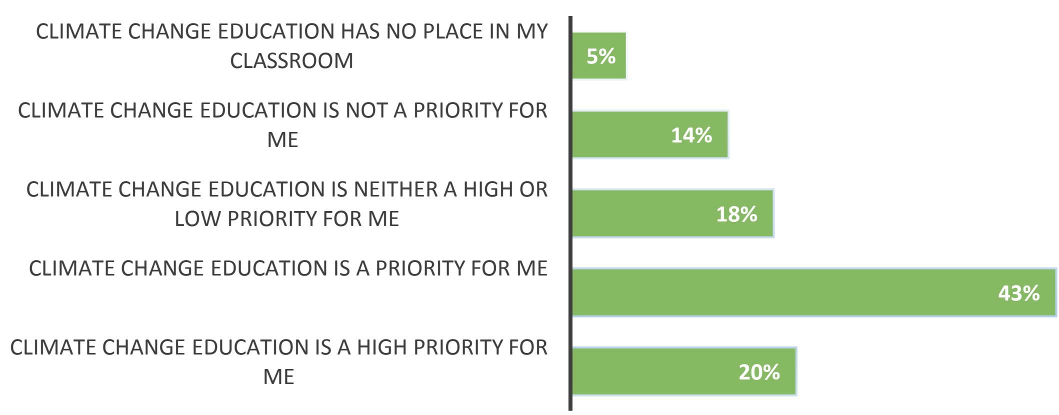


Figure 5.7. Thinking about climate change education, which ONE of the following best describes your opinion? (*n=306*)

Of the participants who identified as science teachers 70.3% viewed climate change education as either a priority (44.6%) or a high priority (25.7%) for them, slightly fewer non science teachers (62.4%) viewed climate change education as a priority (45.7%) or high priority (16.7%). This slight difference was not statistically significant (x^2 (8, *N*=296) = 12.90, P>.05).

A Chi-square test was calculated comparing participants' views about the causes of climate change and their prioritisation of climate change education. A significant difference was found (x^2(8, *N*=296) = 118.57, *p<.001).* Respondents who believed climate change was caused mostly or entirely by human actions were more likely to view climate change education as a priority (55.7%, *n*= 68) or high priority (34.4%, *n*= 42) in their classrooms than not a priority (3.3%, *n= 4) or believe climate change education has no place in their classroom (0%, n =0)* (see Table 5.2). Very few respondents who believe climate change is mostly or entirely caused by natural processes indicated climate change education was a high priority for them (1.8%, *n*=1) (see Table 5.2).

A relationship was found between participants' views on the seriousness of climate change right now and their reported views on the priority of climate change education in their classrooms (F(4, 290) = 70.05, p<.001). Those participants who reported climate change education as a high priority for them (M=5.64, SD=.85) viewed climate change as a more serious problem than those participants who reported climate change education as being a low priority for them (*M*=2.7, *SD*=1.31) or those who reported that climate change education had no place in their classroom (*M*=1.64, *SD*=1.01, p<.001).

Along with feeling climate change education was important many teachers believed they held the knowledge and skills to teach climate change education (see Figure 5.8).

There was no statistically significant difference found between science and non-science teachers reported confidence in knowledge and skills to teach climate change (x^2 (6, *N*=296) = 7.35, P>.05).

Table 5.2

Reported climate change education priority and opinion of climate change cause

Climate change education priority	Opinion on the cause of climate change: Climate change is mostly or entirely caused by natural processes (%)	Climate change is partly caused by natural processes and partly caused by human activity (%)	Climate change is mostly or entirely caused by human activities (%)
Climate change education is a high priority for me	1.8	13.4	34.4
Climate change education is a priority for me	20	45.4	55.7
Climate change education is neither a high nor low priority for me	21.8	27.7	6.6
Climate change education is not a priority for me	36.4	10.9	3.3
Climate change education has no place in my classroom	20	2.5	0

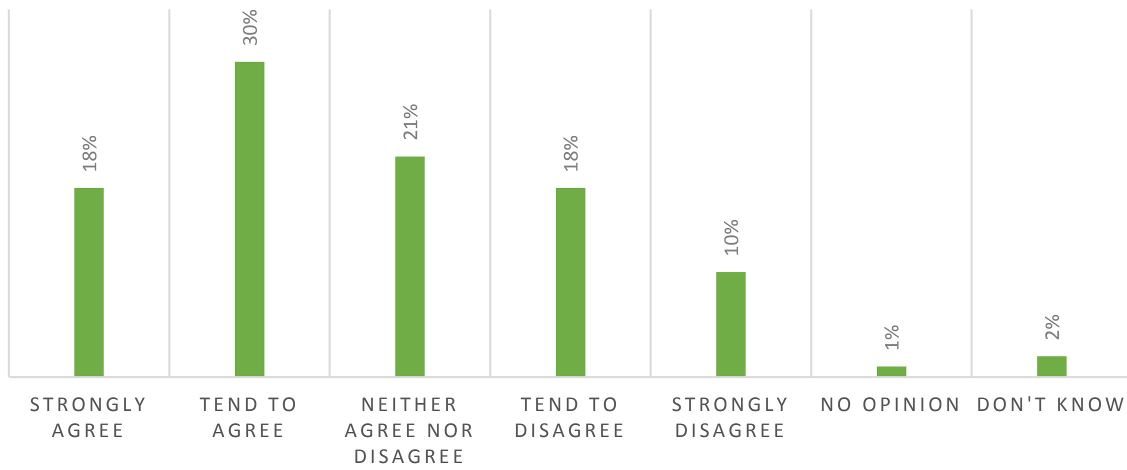


Figure 5.8. I feel I have the knowledge and skills needed to teach climate change education to my students (*n=306*).

Very few teachers believed climate change education was a priority within the school in which they currently worked. Four percent of respondents strongly agreed and 11% of respondents tended to agree with the statement: Climate change education is a priority within my school (see Figure 5.9).

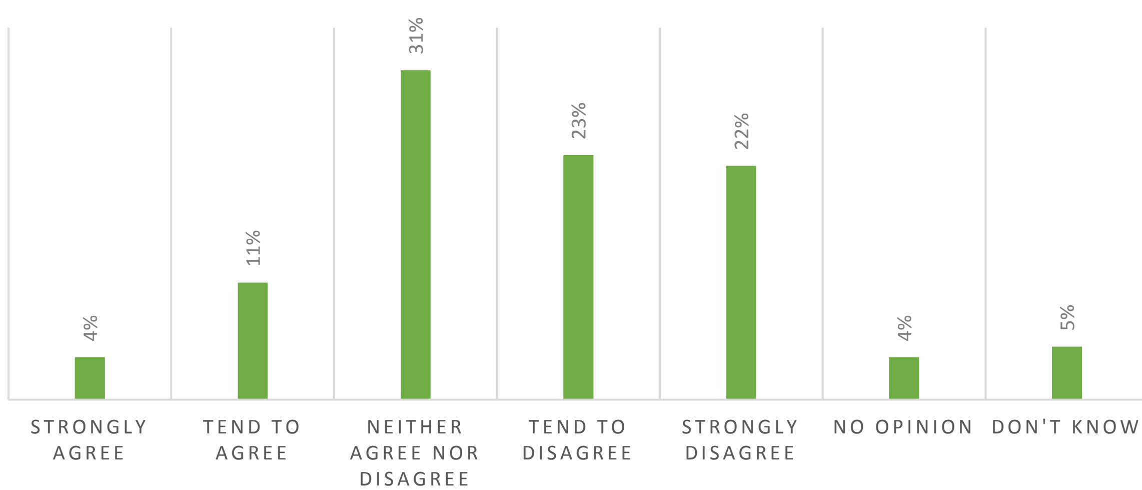


Figure 5.9. Climate change education is a priority within my school *(n=304).*

The interviewed teachers were asked to reflect on why they chose to include climate change as a topic within their classrooms. They identified relevance to the ‘real world’ and the topical nature of climate change as the major factor influencing their decisions:

> *…because it is pretty major and it effects all of us, particularly when it comes to taxation and um spending of government money and stuff like that. Yeah. I mean we’ve got a minister for climate change, that’s just absurd [M, 45-54, S, H3].*
>
> *What would be interesting, so like um, relevance. Real world that was the main thing, the productive pedagogies, making it real world, which obviously makes sense. More interesting and it’s relevant rather than it just being we’re studying this because you should probably know it. Um, so I try to make things relatable to the real world and real life kind of issues [F, 25-64, NS, P2].*
>
> *Definitely topical interest. At the time we last wrote our units there wasn’t an awful lot of emphasis on climate change in the syllabus documents. We didn’t think so anyway. We found in our staffroom we had a few diverging opinions as well. There are a couple of people in the staffroom that felt that the current climate change was no more or less than what happened in the past and then there were others that were very vehement about human contribution. So we had active debate in our staffroom and as a result there was a lot of topical interest in our staffroom and therefore there were people wanting to put it in everywhere and there were others saying well you’ve got to balance that. So yeah topical interest was a big driving force in our staff room [F, 55-64, S, H2].*

Personal interest also influenced teachers and their inclusion of climate change within their classrooms. Teachers identified topics and issues that are of interest to them personally that are often represented in what they teach:

So I was driven to talk about it when I read 'State of Fear', made me change, it's one of those books that you find hard to put down and after you've read it, it makes you think about it for days and days and days afterwards. I read it in one holidays, yeah those sorts of things make you talk about stuff in class and when you have discussions and stuff, if it's interesting to you then it's generally brought up in class [M, 45-54, S, H6].

I teach a QLD syllabus of mathematics that is so lock step and boring and ridiculous. How anybody ever learns to love mathematics these days I don't know. What I do know is I bring my own personal character and you know attitude, so I don't ram we have a problem we should all be worried, can't sleep tonight, that would be the wrong approach. But I do take any opportunity to jump off the, you know, the index or the algorithm or the equation that is relevant to those sorts of areas because if nothing less it interests me, if I'm interested then I'm alive and I'm sparky and if I'm sparking and alive, I'm going to be less boring and more likely they'll enjoy it [M, 55-64, NS, H1].

A small number (less than 10%) of teachers spoke of the autonomy they are afforded within their classrooms that allows for the inclusion of issues teachers feel are interesting and that students would be interested in:

I think it's just the, for me, it's the nature of the profession that it's still a fairly autonomous profession. Even though it seems to be more prescriptive, as far as curriculum and red tape and everything and all the formal testing that goes on now and is recorded, but you're still master of your own class, or mistress of your own class if you have those kids for that whole year [F, 55-64, NS, P3].

Other staff members and administrative support were also viewed as positive influences on the inclusion of climate change within classrooms. One 'champion' teacher within a school was seen as a positive influence and role model to other teachers:

> *It was particular colleague of mine who is a real greeny nutter, I mean I am prepared to do a couple of things for the environment but he was gathering, I think it was 150 litres of water a day from baths and things in 2 litre milk bottles you know. He's a greeny nut, but God bless him he is changing the world [F, 35-44, NS, H1].*

The champion teacher model appears to be widespread, however is likely to be unsustainable due to teacher burnout as noted by one participant:

> *In a lot of our schools that is the situation, you've got the champion model where somebody drives it and drives it really hard and they do great things but then… what we find that that in itself is unsustainable because they generally fall over of exhaustion after a couple of years so [M, 55-64, A, PH1].*

The survey asked teachers to consider specific factors that may have influenced their teaching and curriculum choices in relation to the inclusion of climate change education within their classrooms. Teachers were invited to indicate on a scale from (1) Not at all to (6) A great deal, their beliefs about the level at which each of the listed factors influence their teaching decisions about climate change (see Table 5.3). Personal interest in a topic was seen as a strong positive influence to the inclusion of climate change education for the majority (65%) of teachers (34% rated a 5, 31% rated a 6 or a great deal). Personal beliefs about the role of education were also seen as positively supporting the inclusion of climate change education by the majority (64%) of respondents (33% rated 5, 31% 6 or a great deal).

The school principal and school community did not appear to positively influence teachers' decisions for the inclusion of climate change education. The

Table 5.3

*What would you describe as having an influence on your teaching and curriculum choices to **include** climate change education?*

Influencing factor	(1) Not at all	(2)	(3)	(4)	(5)	(6) A great deal
Personal interest in topic	9%	4%	5%	17%	**34%**	**31%**
School community pressure	**25%**	15%	17%	**23%**	15%	5%
School principal	**29%**	13%	16%	15%	**18%**	10%
Student interest	8%	5%	8%	**25%**	**34%**	20%
Student ability levels	**22%**	9%	11%	**27%**	21%	10%
Students' personalities and maturity	17%	9%	11%	**27%**	**21%**	10%
Personal beliefs about the importance of a topic	9%	5%	8%	20%	**33%**	**24%**
Personal beliefs about the role of education	7%	6%	4%	18%	**33%**	**31%**

Note. The two highest percentages per option are bolded.

interviewed teachers emphasised the power of principal support for long term success with any project or program hoping for schoolwide support. Principal leadership has shown to be a strong influence on teaching and indirectly learning through staff motivations, commitments, and beliefs about the supportiveness of their working conditions (Leithwood, Harris, & Hopkins, 2008). However passive support does not by itself lead to cultural change within schools. School leadership that provides strong proactive direction which actively facilitates change is needed (Evans, Whitehouse, & Gooch, 2012). Making space for the types of reorienting education that climate change demands “requires a disruption of established orderings of… what is and what is not constituted ‘legitimate’ within school practices” (Whitehouse, 2001; 2014, p. 75). It can be said the “principal develops ***the character of the school*** by determining the priorities and school focus at the local level” (AESA, 2014, p. 87, emphasis in original). This kind of proactive leadership support appeared missing from most schools.

5.3.1 Reported Barriers to including Climate Change

When questioned about barriers to including climate change within their classrooms, the teachers interviewed felt the new Australian Curriculum presented some. Teachers felt the main barrier to including climate change was a crowded curriculum and limited time:

> *Time, the biggest barrier in dealing with a lot of these important topics is the crowded curriculum. It’s time, and the space and the time to actually give them the consideration they deserve. So it’s a barrier by default really by a system [M, 55-64, S, H1].*
>
> *I think lack of time would be a big one, because, you know, yeah it would be great to do this but I have to do this and this and this* [F, 25-34, NS, P2].
>
> *I think because there is so much content that is being required to be taught at the moment, driven by the federal government and ACARA I think it’s hard to include it at other points in time [M, 35-44, NS, P2].*

A number of teachers also felt the current curriculum did not include climate change:

> *It’s not currently directly situated within any curriculum documents that I am aware of [F, 35-44, NS, P1].*

The teachers within this study were, for the most part, teaching the Australian National Curriculum in its early incarnation. During the time of interviews all Queensland schools were expected to have implemented Phase one, P-10 learning areas in English, mathematics, science and history by the end of the current teaching year (Queensland Studies Authority, 2012). Since this data collection, all other learning areas have been developed with Phase three currently being implemented. The curriculum has been updated and revised a number of times either through the simplifying or reducing of content in some cases or the increase of content in others (ACARA, 2016).

The Australian Curriculum includes three cross curriculum priorities, they are Aboriginal and Torres Strait Islander Histories and Cultures, Asia and Australia's Engagement with Asia, and Sustainability. The cross-curriculum priority of sustainability is intended to enrich the curriculum by connecting relevant aspects of sustainability across learning areas and subjects (ACARA, 2015). However, teachers in this study were mostly unaware of the cross-curriculum priorities within the National Curriculum with most claiming this priority did not influence their teaching decisions. Those that were aware of these priorities believed they were not a core element of the curriculum. Rather, teachers viewed these priorities as an add-on or an optional extra for those that wish to engage with such issues. Teachers suggested the curriculum was overly full and the addition of discretionary extras would be difficult. Teachers did not appear to view the cross-curriculum priorities as a mechanism for deepening current teaching and learning practices, suggesting there is little incentive for teachers to incorporate these into their teaching (Whitehouse, 2013). Recent Australian studies have also found there to be a considerable lack of awareness of this cross-curriculum priority amongst Australian teachers (Australian Education for Sustainability Alliance, 2014; Dyment et al., 2015). Similar to the Queensland teachers in this study, research has found educators' conceptions of sustainability and the cross-curriculum priority of sustainability to be limited in scope (Dyment et al., 2015) with Australian teachers lacking an understanding of the concept of sustainability and its relevance within the Australian Curriculum (Australian Education for Sustainability Alliance, 2014).

Climate change or sustainability more generally were not viewed as a priority within many schools and in some cases teachers felt they were working within a school culture at odds with the sustainability message:

Even though we say we're only going to have it [air –conditioning] on for two terms a year for example, I know many schools have air conditioned areas and that daily is teaching students something completely against what you'd be teaching on the use of materials. And the amount of photocopying and everything. I think it's the administrative stuff that happens within the school, it goes against the teaching of something like climate change and sustainability in general, really [S, 45-54, S, H4].

[I introduced a program] a few years ago. There were quite a few staff who complained about it, because, I don't know why. It must have obviously been a lot of effort to turn off the fans and lights at lunch time. But you know saying, oh, you know, well why should we turn them off, blah, blah, blah and I think, it's funny being myself that aware of it, how many people seem to not be aware of it. So I want to do a similar thing at the new school that I'm at, but I'm not sure how it will go. For instance we've got air conditioners in every room and I don't put it on unless it's hot… But, I walk into other classrooms at like 8 am and it's freezing and it's on all day. The doors are open and it's still on. There's no, you know, the teachers go home and I might go past their room in the afternoon and the computers are still on [F, 25-34, NS, P2].

Teachers were also concerned with being seen as too radical or stepping too far outside of school or social norms (Evans et al., 2012; Whitehouse & Evans, 2010). One teacher noted their reticence to implement a unit of work in a new school for fear of alienating herself from her colleagues. This teacher recalled negative experiences at a previous school where she attempted an 'energy saving' unit of work with her class. The unit of work encouraged other classrooms to be energy conscious and in this instance teachers were a source of resistance. This memory caused the teacher to question her desire to include similar units of work at her new school as she feared receiving the same response, particularly as sustainability was not a priority within the school.

Another teacher articulated some of the struggles she felt working within a large system that actively negates sustainability teachings through its daily function. This teacher explained the sense of hopelessness and frustration felt when, on one hand sustainability was deemed to be a priority, however the day to day running and practices of the school remained actively at odds with sustainability messages. She expressed a sense of hypocrisy on her part, as she conveyed the importance of sustainability to her students while the school culture worked against her. This sense of futility has led to feelings of frustration in some teachers and apathy in others.

The Queensland Government, Department of Education and Training, Curriculum into the Classroom (C2C) learning resources were seen by many survey respondents as a barrier to including climate change into lessons:

> *I feel the current C2C units only give a very limited opportunity to bring in the ideas of climate change into Science, and SOSE is now limited also. We had more opportunity with many previous curriculums. Essentials, Outcomes, Bound for success, the Pre-Prep program, Early Years Curriculum Guidelines. C2C is much more lock step allowing less opportunity to move with topics that are very relevant to communities that live on the coast and are experiencing greater changes due to climate change [F, 45-54, NS, P].*

> *Since c2c there is little opportunity to deviate from what we are teaching. In the distant past I was able to teach topics that could incorporate it [F, 45-54, NS, P].*

Interview participants also suggested the C2C resources diminished teacher autonomy and limited engagement with climate change (or other topical, relevant issues). Although, some teachers indicated they were required to teach the C2C units, not all schools required teachers to use the C2C documents exclusively or even at all. The teachers who were able to choose which aspects of the C2C resources to use felt the resources were helpful for engaging with the new National Curriculum.

A small number of teachers stated the C2C documents were well conceived and enhanced their teaching. One teacher stated the C2C unit they had used to teach about climate change positively uninfluenced their thinking about the issue:

> *Two years ago, or last year when we taught C2C climate change, and that changed my understanding greatly. So before then I knew about temperatures getting warmer, and ice melting, and carbon dioxide being dissolved in seas and things, now I also encompass things like bison not being, not bison, caribou not being as high up on the slopes as they used to be. Then they're being eaten alive by mosquitos so they're not breeding as much. So more of an environmental or higher environmental picture now. I have an idea of environmental refugees now, people get, when their water becomes too high and their land, their island then starts to go underwater and they have to move. Those sorts of things in the Maldives, is it mal dives? Yeah, so those sorts of things happening there. So my understanding of climate change is much broader now [M, 45-54, S, H6].*

This teacher indicated the C2C encouraged them to research the issue further:

> *The C2C made me do a lot more reading last year [M, 45-54, S, H6].*

This teacher appears to be in the minority however as no other teacher recalled C2C units that explicitly dealt with climate change.

Last, the survey results indicate teachers do not feel that parents are a barrier to the inclusion of climate change education. The majority (58%) of respondents either strongly (28%) or tended to disagree with the statement: I would like to include climate change education within my class but feel parents would not be supportive (see Figure 5.10).

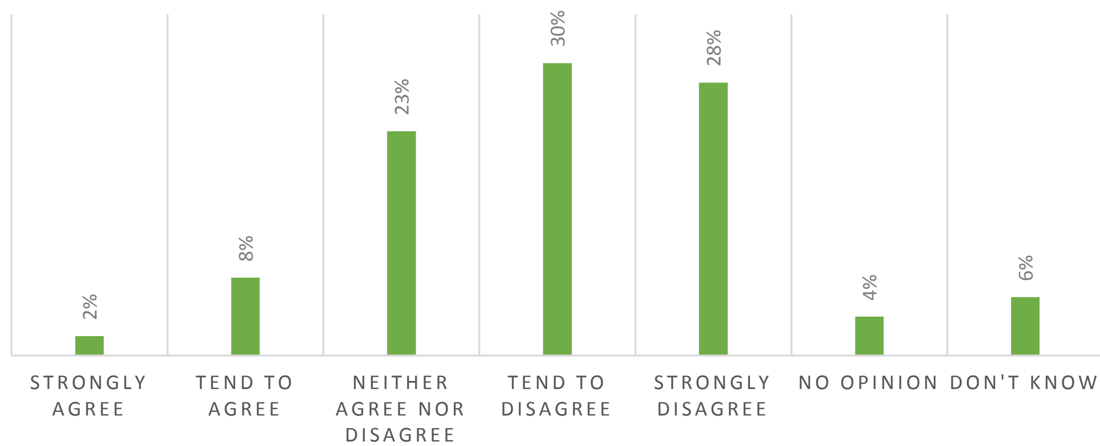


Figure 5.10. I would like to include climate change education within my class but feel parents would not be supportive (*n=305*).

5.4 What do teachers report as their classroom practice in relation to climate change?

While the structural barriers appeared significant to a number of teachers within this study, a small number of teachers' believed it possible to overcome these obstructions. Some teachers found ways in which to include the issues and ideas they were passionate about or that they believed students should be exposed to. One mathematics teacher, for example, spoke of his keen desire to share with his students issues he believed to be important. This teacher found spaces within and throughout his day to day curriculum to inspire thinking about climate change. This teacher did not see barriers, rather he cited his own enthusiasm for the issue as a positive pedagogical strategy. While he argued the content he is required to teach as outlined by his mandated curriculum could be viewed as 'boring' and lead to student disengagement, he believed he was able to breathe life into the mundane through real world examples and genuine enthusiasm.

However, overall climate change did not appear to be a topic that was covered in detail or as a planned unit by most of the teachers interviewed. Some teachers indicated they had included climate change education as a unit on energy or through sustainability units. Although a number of teachers did state they actively sought to include climate change within their lessons or classrooms, most frequently climate change was included when the topic ‘came up’ in class or as incidental conversation.

> *It’s not like in the ACARA curriculum 5.3.0 or anything but um, but certainly when the topic arises or when we’re discussing adaptation and survival and ecology and you know the various factors that can influence adaptation I certainly make a point of mentioning it [M, 55-64, S, H1].*

> *I spend a lot of time chatting to my students and because of the level of awareness created by the [school program] people, we talk about things like the lights and the heaters and the you know, so it’s just part of our daily practice, it’s very much part of our awareness [F, 35-44, NS, H1].*

The survey responses provide additional insight into how Queensland teachers have included climate change education in the past. Respondents were asked to describe how, if at all, they had included climate change education within their classrooms. This question was presented in an open-ended response format where respondents were able to include any length response or choose not to respond and skip the question. Participants were once again not given any criteria or guidelines of what may be included within the concept of ‘climate change education’ and as such, responses to this question rely on teachers own interpretation of what climate change education may include.

When climate change education was included within a planned lesson, it was most typically described as included in a science class, though not typically as a dedicated unit of work. In these instances, issues or topics relating to climate change, such as greenhouse gases or the composition of the atmosphere, may be part of a broader unit. Responses indicated climate change was embedded or included as part of various scientific disciplines including agriculture, biology, chemistry and geology:

> *Senior Biology - in a variety of contexts, Senior Chemistry - not much …Touch on it in a couple of units, mainly when discussing stressors in reef ecology [M, 45-64, S, H].*
>
> *Science units on weather patterns [M, 45-54, NS, P].*
>
> *Year 10 science unit of work [F, 35-44, S, H].*
>
> *I have used geology, the fossil record and plate tectonics to teach about climate change [F, 55-64, NS, P].*

Most often respondents' comments relating to science content covered within lessons were nonspecific e.g. *in science class*, however where more detail was included responses most commonly involved lessons about greenhouse gases and the greenhouse effect:

> *For many years have taught about greenhouse gases, what they are, their sources, including human sources, rise in carbon dioxide and related rises in average temperature [F, 45-54, S, H].*
>
> *Teaching about greenhouse gases and the effects of those on the Earth's atmosphere [F, 55-64, NS, P].*
>
> *Study of the greenhouse effect, global warming, greenhouse gases [F, 35-44, NS, P].*

Although less common than science, Studies of Society and the Environment (SOSE) and Geography were also subject areas where teachers frequently reported having included climate change within their lessons. Within these subjects, climate change was more likely to be the topic or focus of a unit of work rather than one element of a unit as with science. However, as with respondents identifying science, respondents identifying SOSE and geography lessons or units did not specify content covered:

> *Teach a one term unit on it in Year 12 Geography and a one term unit in Year 10 geography, it is also briefly addressed in Year 7 and 8 geography; As a unit in all year levels of SOSE/ Geography with high school classes [F, 55-64, NS, H].*

A common theme for units of work mentioned by respondents that incorporated climate change education was Energy:

> *Yr 9 Science - have covered the burning of fossil fuels leading to higher levels of greenhouse gases which has led to global warming and climate change. Comparison between renewable and non-renewable power sources [M, 45-54, S, H].*

> *Study of the greenhouse effect, global warming, greenhouse gases, sustainable use of resources, renewable and non-renewable energy sources. As part of the science and SOSE subject areas [F, 35-44, NS, P].*

> *I have conducted two energy efficiency units along with water conservation and wildlife conservation [F, 25-34, NS, P].*

A number of respondents viewed climate change education as part of sustainability education or as sustainability education. Responses included statements such as:

> *Enveloped it with sustainability studies [F, 35-44, NS, P].*

> *Access 10 and other certificates have a sustainability unit [F, 55-64, NS, T].*

> *Teaching how students can live more sustainably and minimize [sic] impacts on the environment [F, 25-64, NS, P].*

I used to be the sole SOSE teacher at a school I worked at, so I was able to create units that emplored [sic] *the topic in detail. I used to always teach units about sustainability [F, 25-34, NS, H].*

Another common theme within the sustainability education responses included recycling:

Reduce, reuse, recycle, projects for sustainability including food gardens, worm composting [F, 45-54, NS, ECE].

Everyday attitudes - Needs and wants, Reduce Reuse Recycle etc. [F, 45-54, NS, P].

Year 3 unit on Recycling [F, 35-44, NS, P].

In these cases the distinction between climate change and other sustainability issues was not well-defined and apparently unrelated sustainability issues were listed as climate change education. This finding adds to previous work that has found teachers hold limited or poor understandings of sustainability education (Australian Education for Sustainability Alliance, 2014; Dyment, Hill, & Emery, 2015), and in this case climate change education.

Many teachers indicated they had actively included climate change education within their classrooms. However, a large number of these teachers identified its inclusion as an aside rather than as part of the formal curriculum. Climate change education was frequently reported as being included by teachers solely as part of informal discussions or incidental conversations with students. These conversations took place outside of planned lesson content and were often reported as general in nature:

Only at an informal discussion level; Informal discussions come up at times and I encourage the students to look deeper and wider for more information [F, 45-54, S, H].

General discussions rather than focussed learning [F, 45-54, NS, P].

General "off-topic" discussion with other year levels [F, 35-44, NS, H].

Discussion is seen by many scholars writing and researching in the field of teaching controversial issues as a key pedagogical approach (Hand & Levinson, 2012; Hess, 2002; Hess, 2009). Classroom discussions, particularly those that engage diverse views and are appropriately facilitated, are viewed as an effective method for students to develop a deeper understanding of the views of others, as well as their own deeply held assumptions (Hand & Levinson, 2012). Impromptu discussions allow teachers to engage students in topics of immediate relevance and interest. However, as noted above and in chapter four, a number of teachers appear to hold misconceptions about climate change, and informal discussions, particularly those in areas outside of a teacher's expertise, may serve to hinder the development of student understandings. Classroom discussions are significantly enhanced by effective preparation by students and teachers. Relevant background knowledge and the ability to critically analyse information and evaluate arguments are seen as vital for quality discussion (Hand & Levinson, 2012). The preparation necessary for discussions about complex issues such as climate change is likely to be missing in impromptu, incidental discussions that take place as an aside or outside of the planned lesson.

A small number (less than 10 %) of respondents reported having included climate change education as a means of demonstrating the ways in which scientific information can be distorted, misleading and misrepresented. These respondents typically did not accept the science of climate change and showed a mistrust of scientific processes and evidence. Responses typical of these sentiments included:

I have only mentioned it in the context of studying scams such as evolution [M, 65 or over, NS, P].

I have shown how IPCC manipulate data and graphs to exaggerate the effect - we actually know CO2 levels are the lowest they have been in 200 million+ years...and that CO2 levels do not relate to the Earths [sic] *temperature [M, 35-44, S, H].*

(i) A thorough understanding of all NATURAL cycles. (ii) Demonstration of the way significant scientific research has been altered to support the current anthropogenic climate change nonsense. (NOT EVEN A THEORY) [F, 55-64, NS, P].

As an example of the promation [sic] of irrational hysteria by unqualified idiots [M, 65 or over, S, H].

Finally a number of respondents, when asked how they have included climate change within their classrooms, replied *never* or *have not.* A small number of these respondents elaborated on reasons for not including climate change within their lessons. These responses included a variation of two related themes: 1) climate change not being included the curriculum that they teach and 2) little time or opportunity to engage with topics outside of set curriculum:

I follow the QSA syllabus for Physics which does not include climate change science, Since C2C there is little opportunity to deviate from what we are teaching [F, 45-54, S, H].

These two themes reflect responses from interview participants who also expressed these ideas as barriers to including climate change within their classrooms as outlined above.

5.5 Summary of findings

Overall these findings indicate climate change education is viewed as important by the Queensland teachers in this study, with many indicating climate change education was a priority. Teachers feel they personally have the required content knowledge to include the topic within their curriculum and believe that climate change is a relevant and interesting issue to explore with students. In spite of this position it appears teachers engage in a limited form of climate change education. For the most part they view climate change education as science education focussed on engaging students with the supposed scientific controversy as a means of students choosing a ‘side’ to believe. In many cases climate change is not included as part of formal, planned lessons but rather as part of incidental conversation or general discussions. With little support from curriculum, it appears teachers who are incorporating climate change or sustainability education within their classrooms are doing so on their own. Sustainability education is frequently viewed as a personal crusade by one passionate teacher.

Teacher knowledge of the content being taught significantly influences student learning, particularly when students hold misconceptions (Sadler, Sonnert, Coyle, Cook-Smith, & Miller, 2013). While teachers believe engaging with climate change within their classrooms is important, teachers’ sense of uncertainty or limited understandings of climate change and their indication that both sides of climate change science should be taught, suggests many will do so in such a way that may be unintentionally confusing or misleading. Although closed question survey data indicated teachers may think about climate change education in terms other than balanced science education, for example many agreed that climate change education provided an opportunity to engage with global issues, these broader understandings were not reflected in teachers’ explanations of climate change education.

The limited framing of climate change as ‘science information’ in order for students to form an opinion can be problematic. Climate change is a complex issue where students are likely to hold misconceptions and inadequate understandings (Boon, 2010). Teachers engaging with climate change education from a limited or insufficient understanding of climate change science may lead to inadvertently misleading students through either teaching incorrect information or engaging with the issue in limited ways. A limited conception of climate change education may lead to an overly narrow, insular engagement with the issue. Further, limiting climate change education to the science classroom neglects the broader implications of an uncertain future. Climate change is not merely a scientific or technical issue, it requires the recognition of and engagement with the inherent political, ethical and philosophical complexities (Peters & Wals, 2013) that are characteristic of wicked problems. As Wals and Dillon (2013, p. 256) argue "people need to be become capable of handling uncertainty, poorly defined situations and conflicting or at least diverging norms, values , interests and reality constructions" (Wals & Dillon, 2013, p. 256).

Teachers' conceptions of climate change education.

Teachers:

- primarily view climate change education as climate science education
- believe climate change education should not be the sole responsibility of science teachers
- believe that climate change [science] education involves a 'balanced' approach in which all 'sides of the argument' are presented
- feel strongly that their own opinions or beliefs should not be forced upon students but rather students should be given the opportunity to make up their own minds
- are open to climate change education that includes critical thinking and problem solving, and encourages students to think about their own beliefs and values
- believe the public controversy surrounding climate change should not be ignored

Need for and appropriateness of climate change education.

Teachers believe climate change education:

- is necessary and appropriate for school classrooms
- should be age appropriate
- should incorporate positive messages and instil hope in students while avoiding the more extreme consequences
- should include strategies for making students aware of their own impact on the earth, as well as individual actions students can take

Reported influences on teaching decisions.

- Climate change education was a priority (43%) or high priority (20%) for the majority of respondents
- Teachers who believe climate change is mostly or entirely caused by human actions are more likely to prioritise climate change education
- There was no statistically significant difference between science and non-science teachers reported confidence to teach climate change
- Teachers indicated they include climate change because it is a real world issue that is topical and relevant to students' lives
- Teachers own personal interest in the topic also influences their decision to include climate change
- Climate change education does not appear to be a priority in many schools. Curriculum pressures presented the greatest barriers to the inclusion of climate change for most teachers
- Teachers believe climate change is not included within their curriculum documents
- School culture at odds with the principles of sustainability also presents a barrier to teachers
- The Australian Curriculum cross curriculum priority Sustainability does not influence teacher decision making, many teachers are unaware of the priority

Reported classroom practice.

Climate change education is:

- most often included within science lessons as a component of a wider unit of work
- also included in Studies of Society and the Environment (SOSE) and Geography lessons by some teachers
- viewed by some as sustainability education
- commonly cited as involving only incidental conversations or discussions

5.6 Chapter summary

This chapter reported the findings from the online survey (*n=329*) made available to registered teachers in Queensland, Australia and follow-up interviews with 21 teachers. Findings presented here were related to questions specifically focussed on teachers' beliefs about climate change education. The following chapter six presents a discussion of a number of key findings presented in chapters four and five and considers the research findings in light of the overarching research question guiding this study and the relevant literature.

Chapter Six
Discussion

6.0 Introduction

There is widespread consensus amongst global scientists that the Earth's climate is changing and human actions are a major contributing factor. Even with as yet unseen large scale effective mitigation efforts, changes to the climate will continue for some time (IPCC, 2014). The most recent Intergovernmental Panel on Climate Change (IPCC) assessment report (AR5) summary for policy makers presents a future that will almost certainly include an increase in climate related extremes such as more frequent heatwaves that are longer in duration and changes in rainfall patterns leading to increased droughts and floods. Along with these impacts, climate change is projected to impact human health and compromise food security with the projected impacts likely leading to an increase in the displacement of people, forcing large scale migration, and amplifying the risks of violent conflicts. In the face of such an enormous challenge many are calling for climate change education (McKeown & Hopkins, 2010) with formal schooling having a potentially crucial role to play (Kagawa & Selby, 2010).

Climate change will require education that not only increases knowledge and awareness but that also supports opportunities for participation in learning experiences which allow for "visioning, planning, and [the] implementation of sustainability initiatives" (Zint & Wolske, 2014, p. 188). Climate change will be felt in varying degrees by all, with its impacts anticipated to result in an increase in the number of natural and human made crises. It is important to prepare young people and youth for such disasters including cyclones, floods and bushfires. A resilient and prepared community will help minimise vulnerability even for those in areas where impacts are likely to be ameliorated by relative wealth and effective governance.

Preparedness must also be coupled with co-learning. As we do not fully understand the implications of a future shaped by climate change we must learn by doing through classrooms that are oriented towards "active social learning" (Glasser, 2007; Kagawa & Selby, 2010) that encourages 'out-of-the-box' thinking

(Glasser, 2007). David Orr (2004, p. 27) has argued "[t]he skills, aptitudes, and attitudes necessary to industrialize the earth… are not necessarily the same as those that will be needed to heal the earth or to build durable economies and good global communities". Education will need to take up the challenge of rethinking the world and the taken for granted (Kagawa & Selby, 2010).

The overall aim of this study was to explore teachers' understandings of climate change and climate change education, and how these understandings affect their implementation of climate change education. This chapter critically engages with the research findings presented in chapters four and five by analysing the central findings in each in relation to the relevant literature and the overarching research question guiding this research project: *How do teachers' understandings of climate change and beliefs about climate change education influence their reported teaching of climate change?* Data were collected over two phases and guided by sub-research questions. These sub-research questions focussed on two aspects of interest for this project, which were: 1) teachers' understandings of climate change and 2) teachers' beliefs and reported practices of climate change education.

Findings from this study suggest education systems, within the Queensland schooling system at least, are not adequately taking up the challenge of preparing young people for the future challenge of climate change. Climate change education is a marginalised practice in Queensland schools despite teachers' espoused belief in its importance. Suggested reasons for this are discussed below including (1) a crowded curriculum and high demand assessment and accountability practices which emphasis literacy and numeracy; and (2) teachers' narrow conceptions of climate change education which is a result of (a) their dependency on media for information about climate change which frames teachers' thinking about the issue (e.g. as a controversial issue), and (b) the influence of (cultural, political, religious) worldviews. Teachers' narrow framing of the issue as controversial further creates a sense of its importance as an issue but a false understanding of where the controversy lies leads teachers to assume they need to take a balanced approach to teaching climate change.

This chapter is organised under the following headings: Climate change education as a marginalised practice, Teachers limited conceptions of climate change education, Unbalanced balance, Marginalised climate change education practices in Queensland schools synthesised and finally Chapter summary.

6.1 Climate change education as marginalised practice

Teachers participating in this study indicated strong support for the inclusion of climate change education within formal education, for many it was a high or very high priority. However, formal inclusion of climate change as a planned topic of study within Queensland classrooms did not reflect this support. Despite the high priority teachers within this study placed on climate change education, few believed they had the support to include climate change in any meaningful way. Lack of support from educational policy and school leadership and culture appear to create seemingly insurmountable blockades for a number of teachers and for many "the organisational structures and rules (the 'grammar') of schooling are too powerful a force to change or work against" (Stevenson, 2007, p. 273). Additionally, teachers' conceptions of climate change are narrowly focussed on scientific controversies resulting in a poorly conceptualised or limited understanding of climate change education. In the absence of guiding policy or supportive school contexts, teachers are unable to merge their understandings of climate change education with their current curriculum demands resulting in limited engagement with the issue mainly in the form of incidental or informal conversations.

6.1.1 Unsupportive policy context

The United Nations Framework Convention on Climate Change (UNFCC) and the Kyoto Protocol each contain articles urging governments to support climate change education. The Australian government at the time supported the United Nations Decade of Education for Sustainable development, declaring in *Caring for Our Future, The Australian Government Strategy for the United Nations Decade of Education for Sustainable Development, 2005–2014,* Australia's goal to "mainstream sustainability across the community through education and lifelong learning" (2007, p. 4). Notwithstanding this commitment, Australian policy vis-à-vis sustainability and climate change undertook a substantial redirection in the years that followed.

Currently within Australia, government educational policy foci arguably rests on narrowly defined educational aims, particularly in the areas of literacy and numeracy, and the quantification of student achievement into comparative statistics, or as Lingard (2011) refers “policy as numbers”. These numbers are provided in large part by data collected through the National Assessment Program – Literacy and Numeracy (NAPLAN), an annual suite of literacy (reading, writing and language conventions) and numeracy tests that all students in years 3, 5, 7 and 9 must take. Individual student reports are provided to parents and schools, and the aggregated results of these tests are published for each school on the government developed website *My School,* where results can be compared against national averages, benchmarks and ‘similar’ schools.

The first NAPLAN tests undertaken in 2008 indicated Queensland schools were below the Australian average creating a “political furore in the State” (Lingard & Sellar, 2013). In response the Queensland Government commissioned a review of Queensland student performance, known as The Masters Report (Masters, 2009) resulting in teachers being encouraged to focus on NAPLAN preparation and improving NAPLAN results (Hardy, 2015b). Schools were instructed to focus their attention on NAPLAN testing and on the advice of the Masters Report the Queensland Government advised all Queensland schools to undertake practice tests with the goal of improving the state’s test results (Bligh, 2009).

Proponents of the NAPLAN testing approach argue the value of the testing regime as a diagnostic tool for the improvement of student outcomes and increased accountability for schools (Australian Curriculum, Assessment and Reporting Authority (ACARA), 2016). NAPLAN testing, they argue, allows parents, teachers and schools the opportunity to monitor student and school performance in literacy and numeracy skills from a national perspective (McGaw, 2012). However, others note the consequence of a narrow numbers based policy foci as an inevitable narrowing of the curriculum (Hardy, 2015b; Lingard, 2010; Reid, 2009; Stevenson, 2007) and a focus on teaching to the test (Comber, 2012; Stevenson, 2007). Spurred by the perception of poor performance an intensification of auditing and accountability has taken place across Queensland schools (Lingard & Sellar, 2013). Queensland teachers are "increasingly dominated by broader political and policy concerns for improved test outcomes/'numbers' … with problematic outcomes for practice" (Hardy, 2015b, p. 355). The introduction of NAPLAN testing has resulted in the reduction of time spent on 'non-assessed' areas of the curriculum while increasing time is spent on numeracy and literacy instruction (Polesel, Rice, & Dulfer, 2014).

Alongside the NAPLAN testing focus, the Australian government introduced a national curriculum (Australian Curriculum) in 2012, rolled out over a number of phases. The Queensland Government's Department of Education and Training developed a comprehensive set of planning materials to support Queensland teachers implementation of the Australian Curriculum (Curriculum into the Classroom or C2C) which are intended to be "adopted or adapted" by Queensland teachers as necessary (The State of Queensland (Department of Education and Training), 2015). The C2C resources include detailed unit plans, lesson plans, resources and assessment pieces and have been viewed as a positive teaching and learning aid by some, however, for others their content appears to be overly didactic, leaving little teacher autonomy (Barton, Garvis, & Ryan, 2014). Although perhaps intended to be used in less rigid ways, many schools have taken up a prescriptive approach to their use (Hardy, 2015a).

While teachers may actively resist reductionist pressures of increased test scores and prescriptive curricula, the overwhelming policy and political pressure, usually augmented by the directives or influence of school principals, appears to dominate school practices (Hardy, 2015b). Teachers feel obliged to deliver a prescribed and narrow product into which they have little input (Hargreaves 1994). This separation of planning from execution serves to deprofessionalise teachers (Barton et al., 2014; Connell, 2013; Klenowski, 2011). Teachers within this study indicated feeling frustrated by the accountability demands that reduced teacher autonomy and creativity. Queensland school teachers appear to be tightly constrained in their curriculum and teaching decisions, as participants in this study lamented their loss of choice and inability to contextualise and personalise curriculum content:

> *We are confined to teaching the units and topics that are part of the national curriculum. We no longer really have any choice in what we teach [F, 35-44,NS, P - survey].*

> *I think because there is so much content that is being required to be taught at the moment, driven by the federal government and ACARA, I think it's hard to include it [climate change] at other points in time. Certainly when it does come up in the curriculum. I think that it is a topic that should be included a lot more, I would include it a lot more in the curriculum but I am a bit restricted at the moment about how we can actually do that [M, 35-44, NS, P2].*

6.1.2 Education for Sustainability policy

Education for Sustainability policy appears, at this time, to be absent within Queensland schools. Previously, the driving force behind environmental education policy in Australia has been environmental agencies and not educational authorities (Gough, 2009). While these policies were seen as offering strong support for EFS and in some cases deemed to be quite successful (see for example The Australian Sustainable School Initiative), a period of policy disruption (Stevenson & Nicholls, 2015) has occurred in the Australian EfS field following the successive election of conservative governments, beginning with the election of the Newman Liberal National Party in Queensland during March 2012, followed by the Federal election of the Abbott Liberal-National Coalition Party in September, 2013. During this time of policy disruption all EfS policy documents were removed from Australian government websites, positions responsible for the coordination and support of sustainability education in Queensland were eliminated, the Queensland Sustainable Schools Initiative and the Earth Smart Science Program were disbanded and the Queensland Liberal Party voted in support of a motion that climate change should not be taught in schools (Stevenson & Nicholls, 2015).

The Australian Curriculum does not include a standalone climate change subject nor is there an emphasis within any particular subject on learning for climate change. The Australian Curriculum does however include the Cross Curriculum Priority of Sustainability which is intended to be integrated across the curriculum by teachers where appropriate, and may be seen by teachers as an entry point for including climate change education. Although the Cross Curriculum Priority provides an avenue for teachers to engage with EfS, the inclusion of the priority by teachers or schools is not measured nor does the Australian Curriculum provide explicit guidance on the expected kind or level of integration in teaching and learning practices. So while climate change may be addressed through the Cross Curriculum Priority of Sustainability, the lack of policy support for EfS and the clear mandate for improved NAPLAN test results means that teachers are more likely to teach only that which is mandated (Kuzich, Taylor, & Taylor, 2015; Polesel et al., 2014).

Regardless of the priority's intent within the curriculum, few teachers in this study were aware the priority existed and fewer still believed the priority influenced their teaching practice. Consequently teachers felt climate change education was not something that was easily integrated into their curriculum but seen in many cases as an impossible add-on to a currently overburdened curriculum:

> *I think lack of time would be a big one, because, you know, yeah it would be great to do this- but I have to do this and this and this. So as far as teaching a classroom, I think time impacts that way and also it's just an extra thing that teachers have to do. You know, like if they have to spend 10 minutes a day checking lights or something and they don't have time because they're doing something else [NS F 25-34, P2]*

School culture and principal support appear to be key factors alongside curriculum in supporting teachers to engage in what teachers believed to be extra-curricular content (ASEA, 2014; Evans, Whitehouse, & Gooch, 2012; Leithwood, Harris, & Hopkins, 2008). Principal support is seen as key to the success of any project deemed to be outside of mandated curriculum (AESA, 2014). Teachers within this study generally believed climate change education was not a priority in the schools within which they worked, with some school cultures reported to actively counteract sustainability messages:

> *Even though we say we're only going to have it [air –conditioning] on for two terms a year for example, I know many schools have air conditioned areas and that daily is teaching students something completely against what you'd be teaching on the use of materials. And the amount of photocopying and everything. I think it's the administrative stuff that happens within the school, it goes against the teaching of something like climate change and sustainability in general, really [S, 45-54, S, H4].*

This is not suggesting principals and school leadership teams are purposefully discouraging teachers or students from engaging with such topics, however, principals and school leadership teams must work within departmental and (perceived or actual) community expectations.

Together with the policy context, the relationship between the broader social conditions within which teachers live and work and teacher thinking and practice must also be considered. Along with the removal of government support for EFS in schools, the external political climate surrounding issues such as climate change and sustainability was also hostile around the time this research was undertaken. The then opposition and incumbent governments were engaged in a divisive debate over the Gillard national government's 'carbon tax'. While mass media may not directly drive public opinions, they do significantly contribute to shaping public "perceptions, considerations and actions" (Boykoff, 2011, p. 28). The Australian media focussed its attention on this debate (Bacon, 2013), subsequently eroding public support for climate change action and silencing to some extent the intensifying scientific call for immediate and effective climate change mitigation (Christoff, 2013).

6.1.3 Climate change education in Queensland schools

Given climate change education is not a priority within the Australian Curriculum, individual schools or teachers must prioritise the issue for learning. The previous section however describes a school policy context dominated by performative accountability, where the collection of data exerts significant influence on school and teacher practice. Further, the introduction of a national curriculum supported by Queensland's heavily prescriptive C2C suggests a reduced capacity for Queensland teacher decision making and autonomy. The findings of this study further question the adequacy of current educational policy and curriculum documents in supporting teachers to engage with climate change education. The current educational context examined above and further described by Queensland teachers offers limited opportunity for teachers to engage with the complexities of the issue in ways that are meaningful and relevant to their students. Teachers expressed the belief that their current curriculum is crowded and highly structured through C2C resources and therefore they have limited autonomy for content viewed by teachers to be 'extra'.

Based on self-reported understandings and practice, Queensland teachers are engaging with climate change in limited and superficial ways, most often through incidental conversations with students and not through planned curriculum content (as discussed in chapter 5). Many teachers believed their curriculum does not include climate change and therefore they do not feel they have the flexibility to include climate change in any substantial way. Few teachers in this study were able to find ways to reconcile their strong beliefs about the importance of climate change education with their curriculum requirements.

Although policy makers and curriculum planners wield large influence it is teachers who create their own meaning of policy (Stevenson, 2007) and who make some of the most critical curriculum decisions. Teachers' own beliefs and theories, including those related to the purpose of schooling, teaching, learning, knowledge and beliefs about the subject to be taught, shape their decision making (Stevenson, 2007). How teachers conceptualise climate change and climate change education also appears to affect and limit perceived opportunities for teacher engagement with the issue.

6.2 Teachers limited conceptions of climate change education

Only a small number of teachers within this study were able to construct a version of the Australian Curriculum that they felt both achieved the intended learning outcomes of the subjects they taught, while engaging with climate change content. Science teachers were more likely to feel their curriculum supported the inclusion of climate change, however for the most part teachers who stated they have included climate change within their lessons indicated they did so only through informal or incidental conversation. Although there appears to be considerable policy and political edicts impeding the inclusion of climate change in Queensland classrooms, the acknowledgement that some teachers were able to include climate change in their classrooms in ways they believed both adequately met their curricular demands while engaging with the issue suggests other factors may also be acting to enable or constrain teachers. The results and discussion presented in chapter five draw attention to teachers' beliefs and conceptions about the nature of climate change education and the ways in which climate change may be included within teaching and learning decisions. Teachers, within this study, understood climate change education through limited frames, principally as controversial and as balanced science education. This limited conceptualisation of climate change may work to limit the ways in which teachers are able to see linkages with their teaching demands.

In the absence of supportive educational policy, and guiding curriculum documents that encourage teachers to engage with the complexity of global climate change, teachers rely almost exclusively on their own knowledge of the issue and personal beliefs about its importance for young people to guide their classroom practice. As teachers do not feel supported to include climate change within their school classrooms, they use alternate methods for information gathering and ideas about content, and rely significantly on their own understandings of the issue. Data analysis found that teachers predominantly conceptualised climate change in their personal lives through a small number of frames. Teachers principally framed climate change in terms of emissions, particularly carbon dioxide emissions, temperature changes, and the controversy surrounding the occurrence and current cause of climate change.

6.2.1 Limited framing

The complex and multidisciplinary nature of climate change science, the many scientific unknowns regarding the extent, shape and timescale of the impact of climate change, and misleading public information has resulted in many prevailing misconceptions amongst all members of the general public including teachers and students (see for example: Boon, 2010). These misconceptions have proven to be resistant to change given they are often tied to an individual's identity (Kahan, Jenkins Smith, & Braman, 2011; Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013).

Climate change receives considerable public, political and media attention. Officially, the International Panel on Climate Change (IPCC) represents the mainstream accepted scientific position on anthropogenic climate change. Their periodic assessment reports review, summarise and distil numerous peer reviewed scientific papers on the issue. However, few lay people read peer reviewed scientific documents or the IPCC periodic assessment reports and instead access information about climate change through other means. Climate change is also difficult in most parts of the world, if not impossible, to understand from personal experience. Changes in local climate, with few exceptions, are gradual and masked by random fluctuations and as climate change is personally experienced through seasonal weather variations individual observations and evaluations are difficult (Weber, 2010; Weber & Stern, 2011). Consequently, individuals generally must rely on expert others.

By and large teachers maintain they access almost all information about climate change through the mass media, most predominately online news websites and radio programs. Teachers indicated, when not planning to teach about the issue, they typically do not actively seek information about climate change, rather they gather incidental information as it is reported in the daily news:

> *You know I listen, I find I always hear the news items related to weather as opposed to football for example, I mightn't always hear what is commented on about sport but I always seem to tune in with issues about the environment [SF55-64H3]*

Most typically this is through the radio and online news websites, but other sources include printed news and television.

However, poor media reporting practices can lead to limited exposure to climate change science. Mass media maintains a significant influence on public perception and attitudes on many key issues (Akter & Bennett, 2011; Boykoff & Boykoff, 2007; Malka, Krosnick, & Langer, 2009; Stamm, Clark, & Eblacas, 2000) via the production, reproduction or exclusion of particular worldviews or perspectives (Boler, 2008; Carvalho, 2007). Teachers' general confusion, lack of specific knowledge, belief that there are two equally valid 'sides' to climate change science, and their limited framing of the issue is likely to have been influenced by their exposure to mass media interpretations and representations of climate change and climate change science, or by the 'mass media lens' (Speck, 2010).

6.2.2 Media influence

The ways in which an individual develops "a particular conceptualization of an issue" is known as personal framing. These frames have been described as "what an individual sees as relevant to understanding a situation" (Druckman, 2001, p. 228), what an individual views as "the most salient aspect of an issue" (Chong & Druckman, 2007b) or schematas of interpretation (Goffman, 1974, p. 21) that guide an individual's perception of an issue. Frames effect an individual's evaluation of a situation or issue by placing emphasis on various considerations about the subject (Chong & Druckman, 2007a).

Frames in communication have been argued to play an important role in the way individuals personally frame an issue (Druckman, 2001). The way information is communicated and what aspects of information are emphasised, or *emphasis framing* (Druckman, 2001), can lead individuals to focus on specific aspects of an issue. Media framing, which refers to the process by which mass media select and present information that focuses attention in a particular way, has been argued to influence how issues are understood by audiences (Scheufele & Tewksbury, 2007) and how individuals respond (Spence & Pidgeon, 2010). This suggests the mass media perform an influential role in the way individuals construct reality.

The choices media make about what is newsworthy and who will speak about issues affect the ways in which individuals think about and understand issues. Through both agenda setting, or the emphasis placed on issues, and through issue framing, or the way an issue is described or characterised, the media shape the way many individuals understand the world. Framing climate change mitigation in terms of gains as opposed to losses, for example, increases positive public attitudes towards the issue (Spence & Pidgeon, 2010). Alternatively, framing an issue as primarily a scientific matter or one that requires technological innovation may lead to an individual not feeling directly included.

Hoffman (2011, p. 5) describes climate change as "a contested terrain in which competing movements engage in discursive debates – or framing battles - over the interpretation of the problem and the necessity and nature of solutions". Media representations of climate change impacts were shown to influence teacher understandings of the issue in terms of their immediate conceptions and mental images of the issue:

> *Well, this is mainly referring to global warming and the earth getting warmer. You know I've heard about all of this, all the evidence about the rising ocean, we've already seen the polar ice caps melting and that polar bears will probably become extinct because they won't be able navigate the open water, because it will be too long because they are used to the ice there. Obviously the gases themselves are no good, so that's probably just going to, the pollution is going to increase which means our quality of air is going*

to decrease. Probably see more respiratory kind of diseases, more asthmatics, more. I don't know, whatever other diseases go with that [NSF25.34P2].

Well based on what I've seen and heard, sea levels will rise, who knows by how much, I mean I saw something yesterday on the television that I think it might have been a repeat of catalyst and scientists in Tasmania who have been examining ice cores form the Antarctic they're predicting up to 93 mm you know, it used to be or people used to say metres like ten or five or whatever so sea level rises, so some very small atolls will go under like Kirabas is talking about building that tower that rises out of the sea, so lifestyle, so sovereign nations will disappear [NSF55-64P3].

Another predominant way that climate change has been framed within the public domain is as a controversial issue. The political and media portrayal of climate change as controversial and contested has previously been argued as a predominant influence on individuals' understanding of climate change science as unsettled and contentious (Akter & Bennett, 2011; Boykoff & Boykoff, 2007; Schneider, 2005). There is evidence of considerable differences in the reporting of climate change via mass media depending on the media outlet's ideological standpoint (Carvalho, 2007), including a strong relationship between the political perspective of a media organisation and their interpretation of science and the reliability attributed to scientific claims (Carvalho, 2007). Right leaning print media, for example, are more likely to support sceptical voices (Painter, 2011). Within Australia, a recent study found that up to one third of all articles published in major Australian newspapers do not accept the scientific evidence of human influence on climate (Bacon, 2013). Researchers have gone so far as to claim that some media outlets deliberately aim to mislead the public. Bacon (2013) cites The Daily Telegraph's (News Limited) reporting of the so called 'climategate' allegations of falsifying data as evidence of this. She argues the continued publishing of sceptic columns referencing 'climategate' after an investigation cleared the scientists involved and not reporting the result of the investigation is an intentional misrepresentation of the truth (Bacon, 2013).

Teachers held various understandings of climate change, as outlined in chapter four, including a number of misconceptions about climate change, alongside understandings congruent with mainstream science. However, the principal characteristic of many teachers' understandings was a general belief that the scientific community was unsure of the causes of climate change and the extent of human contribution, and to a lesser extent, whether the climate was changing at all. Teachers expressed their thinking in terms of uncertainty and doubt surrounding climate change science and assertions made about the causes and ultimately the consequences of climate change. For example:

> *Yeah I am very up in the air because, I think it is something that we don't really know, and um, and it's the sort of thing you can't really guess or work out for sure until ten thousand years have passed [S, F, 54-65, H1].*

> *I don't think that we can really prove that one way or the other [NS, F, 35-44, P1].*

Media coverage of climate change, particularly the ways in which uncertainty is reported, can also leave individuals unsure of the scientific evidence (Corbett & Durfee, 2004). Individuals often equate science with certainty (Pollack, 2003). When scientists acknowledge that uncertainties remain, the media and the general public can interpret this as 'scientists do not know anything' (Pollack, 2003). The inclusion of controversy in media reporting also increases perceptions of uncertainty (Corbett & Durfee, 2004). The journalistic ideal of 'balanced reporting', in this case presenting the views of both climate change scientists and climate change sceptics as carrying equal weight, results in what has been called the "dueling scientists scenario" (McCright & Dunlap, 2003). This scenario creates the impression of widespread disagreement, conflict and uncertainty within the scientific community. Additionally, the media often seek extreme positions (McCright & Dunlap, 2003) of for and against further implying widespread and highly polarised disagreement amongst the scientific community. This reporting of climate science as conflict along with very little reporting of scientific findings can serve to mislead or confuse, particularly as teachers within this study are almost exclusively informed about climate change through the mass media.

6.2.3 Worldviews and cultural cognition

The assumption that poor media reporting practices result in an under informed or misinformed public may only partially explain teachers limited framing of climate change and may rest too heavily on a simple linear, unidirectional, information transfer process, where passive receivers absorb a lessoned or impoverished form of science due to journalistic mediation (Bucchi, 2014). Within this model lies the assumption that the public's 'understandings' of climate change are governed by the quality or accuracy of information provided to them. This implies that if the news media were only to more effectively communicate the science of climate change then public concerns, doubts, or confusions would abate. However this idea ignores the role of the individual or information 'receiver'. If this deterministic information transfer model were accurate, we would expect, as more effort is focused on climate change communication and information dissemination, to see an increase in public acceptance and reduced confusion about the issue. However evidence does not suggest this is the case (Ashworth et al., 2011; Reser et al., 2012).

Researchers have explored this issue further and have suggested a number of mediating factors, for example, an individual's poor scientific literacy which may result in judgement errors. Poor scientific literacy, as well as holding incorrect views about specific climate change facts, has consistently been found in populations around the globe (Ashworth et al., 2011; Bostrom et al., 1994; Leiserowitz et al., 2010; I. Lorenzoni et al., 2007; Reser et al., 2012). Low scientific literacy has been argued to account for people's low levels of concern or rejection of anthropogenic climate change. As an extension of this position, researchers have also suggested many people have difficulty in understanding complex systems. Poor mental models of complex systems, it has been argued, result in judgement errors and poor decision making (Chen, 2011; Sterman & Sweeney, 2002).

Yet, what shapes an individual's perception of climate change has been shown to go beyond both the information and knowledge deficit models. Evidence suggests that cultural identity outweighs scientific literacy as a predictor of acceptance or rejection of anthropogenic climate change. Individuals' cultural predispositions have been argued to influence how people engage with information sources and to which sources they ascribe the greatest weight (Kahan & Braman, 2006; Kahan, Jenkins Smith, & Braman, 2011). In this way, what an individual 'believes' about climate change is not a function of how much they know about the issue, rather it is a reflection of what evidence they choose to ascribe weight to. Although teachers stated they did not trust the news media to provide accurate information about climate change, almost all within this study accessed most of their information about climate change through this medium. Teachers qualified this by suggesting they vetted the information they encountered and ascribed credibility based on their own scrutiny of the material.

However, teachers' unconscious biases may lead them to simply disregard information that does not confirm previous opinions. One theory as to why people perceive the same information differently is the Theory of Cognitive Dissonance (Festinger, 1962). Cognitive dissonance can be described as the uncomfortable feeling an individual experiences when a core belief is challenged by contradictory evidence. More recently the Cultural Cognition Thesis argues an individuals' perception of facts is influenced by their identification with a group with strong links to their personal identity (e.g., religious, political, cultural, environmental identity). Individuals tend to make sense of information about how the world works by how they feel it should work, to do otherwise risks cognitive dissonance or placing their beliefs in "conflict with others whose opinions of them affect both their material and emotional well-being" (Kahan, 2010, p.232). People make sense of new information in a way that least challenges pre-existing beliefs or established views (Lorenzoni & Hulme, 2009). Teachers may believe that information they are hearing, that is contrary to their previously held beliefs about climate change, is being distorted in order to preserve their existing core beliefs. People also tend to selectively attend to evidence that supports previously held beliefs or values. In this way teachers may unconsciously expend more effort seeking out information that supports existing theories or beliefs, as well as deem information as more trustworthy if it shares a similar worldview or is simply published or distributed by individuals or groups with whom they share a worldview (Kahan et al., 2011). People may not lack trust in scientists nor question the validity of scientific evidence, rather they may believe the position of their 'group' aligns with scientific evidence (Kahan et al., 2011; Kahan et al., 2012). This is equally true of both people who reject or do not 'believe in' anthropogenic climate change and those that do (Kahan, 2015).

6.3 Unbalanced balance

The limited framing of climate change by teachers is also reflected in the ways in which teachers describe climate change education. Queensland teachers appear to hold narrow understandings of climate change education as limited to increasing students' climate change science content knowledge. Providing a balanced account of the issue, in terms of scientific evidence, was central to many teachers' understandings of climate change education. In the context of political and media controversy surrounding climate change teachers view the issue as topical and important to students' lives. However, also due to the divisive nature of the issue within the public sphere, teachers themselves are unsure of what scientists are saying. As such, teachers believe the best way to engage with the issue is through a neutral or balanced approach. Teachers hold a strong belief that it is not their role to influence student thinking or to force students to accept any one opinion on an issue. This strong aversion to what is believed to be indoctrination, a poor understanding of the scientific position, and a lack of policy or curriculum guidance on the issue coupled with limited conceptions of the climate change leads teachers to poorly constructed understandings of climate change education.

The notion of neutral or 'balanced' climate change science education, or teaching both the mainstream accepted scientific position on climate change (Anderegg, Prall, Harold, & Schneider, 2010; Oreskes, 2004) alongside the minority opposing view, is problematic for a number of reasons. Many teachers feel strongly about the impartiality of their teaching and the importance of impartial neutral education. However, approaching climate change from the balanced perspective as advocated by teachers within this study serves to misinform students.

It is not impartial to suggest there is controversy within the scientific literature or cohort if there is essentially none (Scott & Branch, 2003). There are many legitimate controversial issues relating to climate change that require teachers to engage their students in deliberations and investigations, however whether climate change is occurring or not (it is), and whether scientists believe that humans are the major cause of that change (they do) is not an 'open' issue (Hess, 2009). There remains a difference between the relative certainty of climate change science within the scientific community and the views held by the general public (reasons for this disagreement have been discussed in chapter four). However as Hand (2014, p. 79) argues, "teachers have an obligation to endorse views for which the relevant evidence and argument is decisive, regardless of whether there are people who sincerely hold contrary views".

Curricular decisions should be made based on disciplinary knowledge (Hess, 2009), as such climate change should be approached from the baseline assumption that climate change is a reality and the scientific community accept that human actions are the major contributing factor. The view that anthropogenic climate change should be presented to students as an open debate where various positions and opinions are presented as equally credible to students so they can make up their own mind is irresponsible (Hess, 2009). Finding genuine controversies and debates taking place amongst scientific disciplines studying various aspects of climate change is possible, and examining these controversies is appropriate for some science classrooms. However, if the debate is not primarily scientific, not founded in accepted scientific terms, then it should not be framed as a scientific debate of evidence.

6.3.1 Authentic balance

While a so called 'balanced' approach, or two sided debate on anthropogenic climate change science is not appropriate, students should approach climate change science through investigation and inquiry as a means of developing necessary skills and dispositions, as well as a deeper understanding of the concepts and scientific thinking (Australian Curriculum, 2016). Evaluating the science of climate change is complex. Where knowledge claims are made, each of these should be located on a "degree of certainty continuum" (Dawson, 2000, p. 122). The provisional and contestable nature of scientific knowledge is an important element of understanding science. Formal science classes aim to teach students to think like scientists, to be able to engage with scientific content and be able to make informed decisions. The Australian National Science Curriculum states science education's aim is to develop in students:

> The ability to use scientific knowledge, understanding, and inquiry skills to identify questions, acquire new knowledge, explain science phenomena, solve problems and draw evidence-based conclusions in making sense of the world, and to recognise how understandings of the nature, development, use and influence of science help us make responsible decisions and shape our interpretations of information (ACARA, 2015, para 2).

There is no absolute certainty with scientific (or any) knowledge, with scientists working to reduce uncertainty. In some cases uncertainties remain high and many gaps in understanding exist, and for others the level of uncertainty is low. Climate science education should explore these uncertainties within the boundaries of scientific practice emphasising what and how science claims to know, while recognising the tentative nature of scientific knowledge (Oulton, Dillon, & Grace, 2004).

Ignoring sceptical climate change arguments in science classes should also be avoided however. Examining sceptical climate change beliefs using a scientific approach to knowledge, based on standard scientific assumptions allows students to determine if alternate claims are truly scientific (Bedford, 2010;

Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012). The explicit stating and refuting of misconceptions may also serve to reduce scientific misconceptions in students (McCuin, Hayhoe, & Hayhoe, 2014). Evidence and scientific claims should be examined for quality and trustworthiness, in age and ability appropriate ways (Abd-El-Khalick et al., 2004), and students can explore how scientific information can be distorted and why there may be social controversy around some scientific issues.

The balanced approach to climate change education does have its place when discussing appropriate actions that individuals and countries can take. In this instance teachers should be encouraged to embrace ideological diversity (McAvoy & Hess, 2013) both within their classroom and wider afield. Students should be encouraged to think through various options and opinions in relation to mitigation and adaptation to develop their own ideas. In these instances it is equally important to assess the strength and credibility of each argument. As climate change is a high profile issue, there are many and varied opinions about credible ways forward.

6.4 Marginalised climate change education practices in Queensland schools synthesised

Climate change is challenging to conceptualise and difficult to recognise from personal experience. Anthropogenic climate change is initiated by invisible causes, chiefly greenhouse gases that do not directly impact human health or wellbeing (Moser, 2010). In addition, the impact of climate change appears distant both geographically and temporally, with any local impact diffused by human tendency to live insulated lives in climate controlled built environments, making subtle, incremental changes almost impossible to detect (Moser, 2010).

The complexity and inherent uncertainty surrounding climate change, combined with a lack of personal resonance, delayed gratification for mitigation efforts and complex personal motivations, including political, religious or social values, presents numerous educational challenges, including the need for a wide-ranging scientific knowledge base and pedagogical strategies, including working within uncertainty, that teachers may not hold. Climate change is associated with post normal science where linkages between science and society are substantial and non-linear thinking is required (Brownlee, Powell, & Hallo, 2013). Current knowledge and understandings are not adequate to address many of the issues associated with climate change therefore it is imperative that students are able to “learn their way towards equitable change” (McKeown & Hopkins, 2010, p. 21). The complexity of climate change also requires a more nuanced understanding of expertise, where solutions and pathways do not solely rely on scientific evidence but on critical and creative thinkers who may draw on culture, values, and economic, political, ethical or other considerations when looking towards solutions (Gayford, 2002).

This research has provided insights into teachers’ thinking and engagement with climate change and climate change education in the context of Queensland schools. Although teachers place a high priority on climate change education, they do not believe climate change education is included in the curriculum they are required to teach. Climate change is viewed as an addition to intended curriculum which requires teachers to find space in what they report as an already crowded curriculum for its inclusion. Currently there are no guiding or supportive educational policy documents that encourage Queensland teachers or schools to include climate change, and the Australian Curriculum, including the cross curriculum priorities, do not appear to support teachers with the inclusion of climate change in any consistent way. Top down educational policy focussed on narrow definitions of ‘success’ limit the ways in which schools and teachers are able to engage with ‘non assessed’ additional curriculum (Polesel et al., 2014) limiting teachers’ feelings of autonomy and their ability to include, in the absence of supportive policy or curriculum documents, climate change education. This research suggests the current numbers-focussed policy context driving much of school practice actively works against the kind of unfamiliar learning climate change requires.

Some teachers were able find links between their mandated curriculum and climate change education suggesting the curriculum may provide opportunities for engagement with climate change education. However, in the absence of supportive or guiding policy and explicit curriculum, teachers must rely on their own interpretations and understandings of climate change and climate change education to guide their practice. A reliance on independent learning has resulted in many teachers holding limited conceptions of climate change and climate change education. Queensland teachers, like most Australians, mostly learn about climate change through their engagement with mass media, these understandings are also filtered through teachers' prior beliefs, values and unconscious biases. As a result, teachers view climate change education as 'balanced' science education which limits the ways teachers are able to find avenues to include the issue in their day to day teaching and curriculum and arguably is likely to lead to the unintended outcome of misleading students.

6.5 Chapter Summary

This chapter offered a number of possible explanations for the marginalisation of climate change education in Queensland schools including an unsupportive curriculum and policy environment, and teachers own limited conceptions of the issue. The following chapter will provide a brief summary of this project, discuss the implications of this research for climate change education and Queensland schools, outline specific recommendations for policy and practice and suggest directions for future research.

Chapter Seven
Conclusion

> *If schools are to fulfil their potential and help the transformation towards a sustainable future, teachers, curriculum developers and school administrators must come to a deep consciousness of the global realities that beset humanity, appreciate the imperatives of reorienting education systems and curricula towards a future that can be sustainable, and develop and promote a range of curriculum and teaching approaches that are committed, ethical and effective in empowering young people to dedicate their lives to sustaining their, and our, common future (Fien, 2001, p. 4)*

7.0 Introduction

This final chapter explores the implications of the findings and explanations offered in this study. First a brief summation of the study is presented to remind the reader of the general findings followed by a summary of the main research findings. Next, the implications of this research for climate change education in Queensland schools are discussed. Finally, specific recommendations for policy and practice are outlined, followed by suggested directions for future research.

7.1 Brief summation of the study

This study aimed to explore teachers' understandings of climate change and climate change education, and how these understandings affect their implementation of climate change education. The research was undertaken using a two-phase mixed methods approach. The first phase of data collection sought to gather data, via the administration of a survey, from a wide range of participants to form a general picture of the research problem (Creswell, 2011). The survey data were used to yield information outlining the statistical frequency of trends through closed response questions, as well as, identify themes through open response questions. The second phase of data collection involved one-on-one interviews with selected participants via telephone. Participants in this study were Queensland teachers, registered with the Queensland College of Teachers with primary and secondary teachers most predominantly represented.

Specifically this study sought to answer the overarching research question: *How do teachers' understandings of climate change and beliefs about climate change education influence their teaching of climate change?*

The exploration of this research question was guided by seven sub-research questions:

Climate Change

1. How do teachers understand climate change?
2. What are the sources of information teachers use to inform themselves about climate change?
3. What are the personal beliefs of teachers about the causes and consequences of climate change?

Climate Change Education

4. What does climate change education mean to teachers?
5. What are the beliefs of teachers about the need for and appropriateness of climate change education?
6. What do teachers report as influencing their decision to include or exclude climate change in their curriculum?
7. What do teachers report as their classroom practice in relation to climate change?

7.2 Key findings

Climate change: How teachers understand climate change was considered over six dimensions.

Awareness: All teachers are aware of climate change, all have heard of the term and know that climate change is of concern to some people. Many teachers felt they knew a lot about the issue with no participants indicating they knew nothing at all.

Knowledge: Teachers, like the general public, vary in their knowledge of climate change. The survey suggests teachers are slightly more knowledgeable about climate change science than the general public, however, science teachers do not appear to be more knowledgeable than non-science teachers. The data suggest teachers hold a narrow conception of climate change, limited to a focus on causes and a small number of consequences. Most commonly teachers spoke in terms of anthropogenic causes.

Beliefs: The majority of teachers indicated they believed that the Earth's climate was changing, with the survey indicating that the majority of teachers believe that human activities are at least in part the cause. Many indicated they believed that most scientists agree that humans are causing climate change.

Risk perceptions: Teachers did not feel there was a personal, immediate threat from climate change. The survey indicated that teachers believe climate change poses a risk to Australians, however, interviews suggest most teachers view the consequences of climate change to be distant. Teachers who perceive future risk were more likely to believe climate change was caused by human activities.

Responses: Teachers indicated support for mitigative responses to climate change. Although teachers felt mitigation was important few felt positive about the likely success of any such efforts, particularly individual actions. Adaptation was not identified by any teachers as a possible response to climate change, when prompted some teachers indicated that adaptation may be appropriate for some people in the future.

Engagement: Although teachers indicated a pessimistic outlook on the effectiveness of mitigation, survey responses indicated a more positive outlook on personal actions. Survey data suggest individual actions were seen to positively contribute to the environment and the community, as well as promote positive personal thinking. Teachers are somewhat interested in following environmental and climate change news, however, they do not trust the news media for accurate information about climate change. Teachers trusted scientists a great deal, followed by the government and media.

Information sources: The predominant source of information for teachers about climate change is the mass media. Although teachers within this study reported they usually did not actively seek information about climate change unless preparing for a lesson, interviewed teachers indicated they would actively read or listen to news reports when climate change was mentioned. Interestingly, no one responding to this research completely trusted the media as a source of information about the environment or climate change. When actively seeking information about climate change, when preparing for a lesson for example, teachers typically reported using the internet or Google as a starting point.

***Climate change Education*:**

What does climate change mean to teachers? Teachers view climate change education as a balanced representation of the multiple positions held on climate change science. The survey data indicated teachers felt that climate change education should primarily focus on scientific understandings. Many teachers focused on students developing an understanding of the causes of climate change. This focus was primarily with the intent of allowing students to develop their own opinion on the causes of current climate change. Notwithstanding the science focus, teachers believed climate change education was the role of all teachers and not just the responsibility of science teachers. Teachers also indicated the controversy surrounding the issue should not be ignored by teachers. They strongly agreed students should be made aware of the controversy and that a teacher's own beliefs about the issue should not be forced upon students as the right or only answer.

Need for and appropriateness of climate change education: Teachers viewed climate change education as important and necessary. They felt that climate change should be age appropriate and not include the more extreme issues including mass extinction or security issues. Teachers did not feel students felt hopelessness or despair in relation to climate change and viewed climate change education as a way of instilling hope and excitement about a future in which their students have a key part.

***Influences on teaching and learning*:** The survey indicated climate change education was a priority for many teachers with very few teachers indicating climate change education had no place in their classroom. Teachers felt they had the knowledge and skills needed to teach about climate change. Yet despite teacher support, few teachers felt climate change education was a priority within their school. The greatest reported barriers to the inclusion of climate change education were time and curriculum pressures. A number of teachers reported climate change was not in their prescribed curriculum and as such found it difficult to find the time or space to include the topic. For those teachers that did include climate change, personal interest in the issue and the relevance of climate change to students' lives was an important motivator.

Reported practice: Climate change for the most part is not included as a planned unit of work or topic to be covered. Teachers indicated climate change was most typically included as incidental conversation or discussions. When climate change has been included as part of a planned lesson or unit of work, most typically it has been included within science lessons. "Energy' was most commonly cited as a theme for climate change units. Largely climate change was seen to be part of sustainability education, with respondents often conflating non-related sustainability issues with climate change specific sustainability related content.

7.3 Implications for climate change education in Queensland schools:

How do teachers' understandings of climate change and beliefs about climate change education influence their teaching of climate change?

Based on self-reported understandings and practice, Queensland teachers are engaging with climate change in limited and superficial ways. This research suggests in the absence of supportive educational policy and curriculum that evoke opportunities for a broad interdisciplinary approach to climate change, the ways in which teachers personally frame climate change will continue to limit their thinking about educational possibilities. Teachers view climate change as predominantly a scientific issue that is controversial, as such they understand climate change education to be 'balanced' science education. Additionally, evidence from this study suggests Queensland students encounter limited organised engagement with climate change within the formal schooling system with many students unlikely to take part in planned climate change lessons, rather engaging with climate change only through informal or incidental conversations with their teachers.

The findings from this study have implications for understanding how climate change education is being engaged within Queensland schools. There appears to be a pervasive gap between the possibilities of climate change education and teachers' current conceptions and practices. Queensland teachers feel climate change education is important and appropriate and many believe climate change education is a high priority for them, however, this enthusiasm does not translate into meaningful climate change education practice. Teachers do not feel supported to engage with climate change by their curriculum or policy documents nor, for the most part, by their school contexts and culture, and therefore rely on independent learning and motivation. Strong foundations in government policy, clearly defined governance, strong support and resourcing, along with sound curriculum and professional development are viewed as key to an effective response to climate change through education (UNESCO, 2015). An effective educational response to climate change must move beyond environmental awareness (UNESCO, 2015) or limited science education, which were the primary focus of teachers within this study, and develop an understanding of the impact of climate change and educational opportunities which enhance resilience and adaptive capacity.

Teachers' limited conceptions of climate change and climate change education, and the absence of professional learning and guiding curriculum and policy to illuminate the interdisciplinary ways in which climate change may be engaged with in the classroom, appears to result in limited and unconnected climate change education in Queensland schools. When climate change education is included, it is likely to involve limited science education to expose students to the various community positions on the causes of climate change, with the explicit intent of students' determining their own position on the issue. There does not appear to be a well-structured or sequenced engagement with climate change that develops a comprehensive understanding of the issue over multiple year levels. Nor are there any cross-curricular ties where students are able to develop a sophisticated understanding of the issue and the capacities and dispositions that futures shaped by climate change will require. It appears Queensland teachers limited conceptions of climate change and the possibilities of climate change education limit this learning to debates surrounding causes.

Reminiscent of environmental education within Australia which has historically been marginalised with Australians schools (Gough, 1997), at this moment, climate change education in Queensland schools is firmly reliant on the onus of an engaged motivated individual teacher who has the initiative, commitment and dedication to find the time and make space for engaging with the issue. As such, climate change education takes place in Queensland classrooms in fragmented ways.

7.4 Recommendations for policy and practice

David Selby (2008, pp. 252-253) writes;

> An adequate responsiveness on the part of schools to climate change would in most cases require a cultural shift of significant, even seismic, proportions. A culture more often than not characterized by right answers, the comfortable certainties of *ex cathedra* teacher pronouncements, a linear understanding of casualty, predominantly single text-book driven learning process [and attendant failure to complexity issues], and student passivity would need to give way to a culture of uncertainty, systems consciousness, a dynamic sharing of subjectivities and multiple voices, and action oriented learning.

Teachers within this study indicated strong support for climate change education, therefore initiatives to include climate change should be met with broad based support from the teaching profession. Yet, in the absence of strong, supportive policy emphasising the importance of climate change education, curriculum documents that provide space and entry points, and professional learning to broaden understandings, teachers are likely to continue to include climate change in a piecemeal fashion, guided by their own initiative. This research proposes meaningful climate change education will require leadership in the form of policy and curriculum support, comprehensive and timely professional learning and quality educational support materials which embrace the complexities and uncertainties of climate change, as a foundation.

Given the influence policy directives appear to have on Queensland schools, principals, and in turn teachers' school practice, policy must explicitly support all levels of schooling to engage with climate change education. UNESCO (2015) makes recommendations for policy makers for the successful integration of climate change education. They suggest governments need to take a coordinated approach which integrates climate change education into all levels and types of education and across the curriculum, while providing support for the appropriate mechanisms to assist with policy integration (UNESCO, 2015). Climate change education must be valued by education departments and governments and supported by their stated goals and directives. The current policy climate in Queensland not only fails to support climate change education, it has been argued that it effectively discourages schools and teachers from engaging with climate change education through the removal of all supportive EFS policy (Stevenson & Nicholls, 2015) and an emphasis on narrow prescriptive aims. In comparison, recently the Portland school district, Oregon USA's largest school district, passed Resolution No. 5272, "Resolution to Develop an Implementation Plan for Climate Literacy" (Portland Public Schools, 2016), which endorses the development of an implementation plan to include climate change curriculum and educational opportunities into all Portland Public Schools (Portland Public Schools, 2016). Thoughtful supportive policy informed by research and practice (Stevenson, 2013) must also be accompanied by and endorse curriculum and professional learning that explicitly supports and guides teachers with the inclusion of climate change education.

For climate change education to be taken up more widely by Queensland teachers and in a way that moves beyond limited 'balanced' science, curriculum developers need to recognise the urgency and importance of climate change in the lives of current and future students and prioritise learning that engages with climate change in meaningful ways that builds, develops and supports the necessary capacities in students for an uncertain future. Findings from this study suggest the necessity for curriculum that explicitly engages with appropriately sequenced, cross-curricular climate change curriculum, which allows for well-coordinated, developmentally appropriate learning, and that supports teachers with its implementation. Given the curriculum demands teachers are currently working under, additional inputs are untenable therefore climate change must be integrated into current teaching and learning requirements. In order for climate change to be comprehensively addressed, curriculum must be reviewed with the aim of developing and strengthening the curriculum to include climate change across all levels (UNESCO, 2015). Climate change impacts and approaches to adaptation are by nature local issues (IPCC, 2014), therefore curriculum should avoid overly prescriptive language and allow teachers the freedom and support to teach locally relevant content in appropriate contexts (Davies & Pitt, 2010). Student engagement must be genuinely valued (Davies & Pitt, 2010) and schools encouraged to develop partnerships with the wider community to work together in learning about and for the future (Reed, 2010). Based on the findings of this study and others (for example: Dyment, Hill, & Emery, 2015), the sustainability cross curriculum priority, in its current incarnation, is unlikely to be an effective means of encouraging teachers to incorporate complex issues such as climate change.

As this study suggests teachers feel climate change science is controversial and that they must not influence students' thinking about controversial issues, the curriculum must endeavour to depoliticise the issue of anthropogenic climate change. The scientific position on the causes of climate change, as well as the position on climate change occurrence and cause that the curriculum endorses should be made clear, while allowing space for students to engage with the complexities and controversies surrounding the issue. Teachers must feel secure that they are not indoctrinating students with their own personal beliefs and that the curriculum is supported by scientific evidence and is based within scientifically accepted terms. Teachers are curricular gatekeepers (Hess, 2009; Thornton, 1989), and as Cotton (2006a, p. 80) states "any attempt to introduce a more radical environmental agenda into schools by making changes to the curriculum will not succeed unless teachers can be convinced that it is desirable”. The strong belief of teachers that they must remain impartial and not influence student thinking, coupled with the belief that climate change is a controversial issue, suggests any attempt to introduce a climate change curriculum more in line with current scientific consensus will not be successful unless teachers accept climate change science as uncontroversial.

If climate change education is to be efficacious, policy and curriculum support are necessary but likely insufficient (Wise, 2008). For a ‘seismic’ shift (Selby, 2008) to occur teachers must also understand the need for change and the implications of change on classroom practice (Walker, 2003). Policy enactment is a socially founded and contested process (Hardy, 2015). Educators contextualise and transform policy discourse “into their own discourses of practice, and most importantly, into pedagogical actions” (Stevenson, 2007, p. 269). Currently teachers hold limited climate change and climate change education understandings. These limited conceptions of climate change and climate change education constrain teachers’ ability to engage with genuine controversy and alternate futures oriented thinking, including climate change adaptation. The teaching and knowledge required for a wide-ranging educational response to climate change will necessitate effective support and guidance. Teachers and pre-service teachers must be adequately prepared with opportunities to enhance their knowledge with accurate, up to date understandings while developing new teaching practices. As this study indicates that teachers are unsure of the scientific consensus, professional learning opportunities must also enable them to develop an understanding of the scientific position on climate change, as well as an appreciation for what is well understood and what areas are less so. Professional learning should emphasise what evidence exists to support the scientific position on anthropogenic climate change and what the likely consequences of a changing climate will be, including the implications for current and future times.

However, although teachers indicated they trust scientist for information about climate change, evidence suggests that information about climate change science alone is unlikely to see large scale changes in teacher ‘beliefs’ or feelings about the issue (Kahan, 2015). It is important to acknowledge the implications of teachers' own cultural predispositions and how these may shape teachers knowledge and understandings (Kahan, Jenkins Smith, & Braman, 2011). Kahan (2015, p. 33) asserts it is "the people in their everyday lives whose guiding example ordinary members of the public use to figure out *what* evidence of scientific belief they should credit and which they should dismiss". Arguing that although scientists have a vital role to play in climate science communication, when it comes to ordinary members of the public, climate change must be communicated by the public themselves (Kahan, 2015). One approach which may successfully engage diverse teachers in climate change professional learning is collective learning through teacher communities of practice. Communities of practice allow for teachers to collectively work to solve problems, request information or seek experiences (Wenger, 1998). The benefits of social learning in teacher professional learning are increasingly recognised, with teachers' involvement in professional learning communities supporting commitment, engagement, lifelong learning and changed practices (Mayer & Lloyd, 2011). These communities may be developed within single schools, across regions or further afield through the use of online communication technologies.

This learning should dovetail with learning that aims to develop a richer, more comprehensive engagement with climate change that moves beyond scientific understandings of causes and "business as usual parameters" (Kagawa & Selby, 2010b, p. 5). Professional learning should offer teachers the opportunity to develop skills that enable learners to participate in examining underlying ethical and social issues, explore personal meanings and values, recognise and negotiate with diverse ideological personalities and generate possible solutions and alternate futures including reorienting, negotiating and reinterpreting realities (Gonzalez-Guardiano & Meira-Cartea, 2010). This learning should offer guidance on how teachers can make the connection between what they are learning and the curriculum they teach, by engaging teachers in curriculum analysis to identify opportunities within their current curriculum to engage with climate change education teaching and learning. Teachers do not necessarily need to become experts in all facets of climate change, rather willing participants in co-learning with their students.

Explicit curriculum inclusion and professional learning should also be supported by quality educational resources. Teachers who intend or wish to teach climate change indicate they feel unsupported and ultimately search for information about the issue online. While there are a number of high quality climate change education resources available online, in many cases the focus is on science education. The internet also contains much information that is misleading and designed to misinform. Quality learning resources would not only avoid the unintentional use of misleading material by teachers, they would also save teachers valued planning time as well as have the potential to aid teacher learning. Teaching resources should be developed that aim to "provide students with opportunities to explore the richness of the interactions between science and society rather than being confronted with a limited two-sided debate about [the] issue" (Cross & Price, 1996, p. 330).

7.5 Directions for future research

This research investigated Queensland teachers only. A wider sample that includes teachers from the other states and territories within Australia would provide a richer understanding of teacher beliefs and the variations over various geographical regions. Further to this, the following directions for future research are prompted by the findings and limitations of this study:

Research is needed to investigate planned, enacted, and experienced climate change education curriculum.

a. This study concentrated on developing an understanding of teachers' stated beliefs and practices and as such findings are limited to reported practice. Further research is needed to understand how stated beliefs translate into classroom practice. This work may involve the examination of teachers' stated intentions, a review of teaching and planning documents and lesson/classroom observations.
b. Further research is also needed to explore how professional development may best be placed to aid teachers in developing a more robust and comprehensive understanding of climate change

and climate change education and how to best to engage and support teachers in thinking about the issue.

c. As climate change is a difficult topic to communicate effectively to diverse populations research may seek to investigate the efficacy of communities of practice for teacher learning and engagement with complex issues such as climate change education.
d. There will likely remain teachers who do not accept anthropogenic climate change, however this research suggest almost all teachers accept the climate is changing regardless of the cause. Research might investigate the sub group of teachers who accept the climate is changing but not anthropogenic influences. For example: Do/can teachers who accept the climate is changing but not human influence focus on the implications of climate change, regardless of causes?

Understanding student experience.

e. As this survey suggests teachers hold some misconceptions, research is needed to understand the extent to which teachers' misconceptions about climate change are included in their teaching practice and how these effect student knowledge and engagement.

7.6 Conclusion

Many have argued the importance of a science literate population including Australia's current Prime Minister Malcom Turnbull (2015), however, alongside the notion of climate science literacy, there is a growing call to move beyond students simply understanding climate change in a scientific sense (for example: Gonzalez-Guardiano & Meira-Cartea, 2010; Kagawa & Selby, 2010a). Educating *about* change, or 'climate' education (McKeown & Hopkins, 2010) is vitally important and climate change science education is a valuable contribution. Equally as important as climate education, is educating *for* change, or 'change' education (McKeown & Hopkins, 2010), which aims to engage learners with the skills and dispositions to engage meaningfully in a future shaped by uncertainty and transformation.

The findings of this study provide timely and informative insight into a topic that requires further exploration and attention. Climate change education will require teaching and learning that moves beyond current taken for granted assumptions and engages with “rethinking the world” (Kagawa & Selby, 2010b, p. 5). If there is enough time and will to make the changes necessary is yet to be seen, however the future will come inevitably. Today’s young people will have little choice but to actively engage with climate change and as such, the significance of climate change education to prepare young people to have the capacity to engage thoughtfully and make good decisions about mitigation and adaptation responses cannot be understated.

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Appendix A

Climate change in the Australian Curriculum

Climate change appears as a content descriptor with elaborations supporting its inclusion once in the current version of the Australian Curriculum. Within the Science subject area, Earth and Space Science.

Subject	Content	Elaboration
Earth and Space Science Year 10	Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere	investigating how human activity affects global systems modelling a cycle, such as the water, carbon, nitrogen or phosphorus cycle within the biosphere explaining the causes and effects of the greenhouse effect investigating the effect of climate change on sea levels and biodiversity considering the long-term effects of loss of biodiversity investigating currently occurring changes to permafrost and sea ice and the impacts of these changes examining the factors that drive the deep ocean currents, their role in regulating global climate, and their effects on marine life

Presented below are the results of content searches for words associated with climate change as a means of discovering entry points for climate change within the curriculum. The tables below begin with mentions within Learning statements, Subject overviews, Subject descriptors and Subject glossaries. These results are followed by specific Year level subject learning content and elaborations. Subject content statements are content that must be taught, elaborations are suggested contexts.

Note. Each table will list: Total number of mentions [#X] followed by (number of mentions with links to teaching climate change)

Climate change 14X (13 mentions with links to teaching climate change)

Cross Curriculum Priority Sustainability statement	Sustainability In the Australian Curriculum: Languages, the priority of sustainability provides a context for developing students' capability to communicate ideas, understanding and perspectives on issues and concepts related to the environment. The Australian Curriculum: Languages contributes to students' capabilities to investigate, analyse and communicate concepts and understandings related to sustainability in broad contexts, and to advocate, generate and evaluate actions for sustainable futures. Within each language, students engage with a range of texts focused on concepts related to sustainability. These include: environment conservation social and political change linguistic and cultural ecologies change, both within the target language and culture, and across languages and cultures in general. In this way, students

	develop knowledge, skills and understanding about sustainability within particular cultural contexts. This is crucial in the context of national and international concerns about, for example, climate change, food shortages and alternative ways of caring for land and agriculture. Through developing a capability to interact with others, negotiating meaning and mutual understanding respectfully and reflecting on communication, students learn to live and work in ways that are both productive and sustainable. Learning Aboriginal languages and Torres Strait Islander languages contributes to the global effort to exchange knowledge among people with varied practices in caring for the land. It also contributes to the reconciliation process in Australia and goals for language revival.
Geography Overview Place	The sustainability of places may be threatened by a range of factors, for example natural hazards; climate change; economic, social and technological change; government decisions; conflict; exhaustion of a resource and environmental degradation.
Science descriptor Relationship between the strands	They will also recognise how this science understanding can be applied to their lives and the lives of others. As students develop a more sophisticated understanding of the knowledge and skills of science they are increasingly able to appreciate the role of science in society. The content of the science understanding strand will inform students'

		understanding of contemporary issues such as climate change, use of resources, medical interventions, biodiversity and the origins of the universe. The importance of these areas of science can be emphasised through the context provided by the science as a human endeavour strand, and students can be encouraged to view contemporary science critically through aspects of the science inquiry skills strand; for example, by analysing, evaluating and communicating.
Year Level	Content	Elaboration
Year 6 HASS Australia in the past and present and its connections with a diverse world	Examine different viewpoints on actions, events, issues and phenomena in the past and present	- analysing where points of view differ about global issues and exploring the reasons for different perspectives (for example, reasons for varying views on issues such as climate change, coal seam mining, or aid to a country of the Asia region; different world views of environmentalists)
Year 8 History The Ancient and Modern World	Theories of the decline of Angkor, such as the overuse of water resources, neglect of public works as a result of ongoing war, and the effects of climate change	

Year 9 & 10 Media and Arts	Evaluate how technical and symbolic elements are manipulated in media artworks to create and challenge representations framed by media conventions, social beliefs and values for a range of audiences	- discussing film work they have made and viewed to identify and explain how technical and symbolic elements, such as camera techniques, editing, sound rhythm and mise-en-scène, evoke a personal response such as excitement or fear, or convey an issue or idea such as differing opinions about climate change
Year 9 Geography	Challenges to food production, including land and water degradation, shortage of fresh water, competing land uses, and climate change, for Australia and other areas of the world	- exploring environmental challenges to food production from land degradation (soil erosion, salinity, desertification), industrial pollution, water scarcity and climate change
Year 10 History The moderns world and Australia	Responses of governments, including the Australian Government, and international organisations to environmental threats since the 1960s, including deforestation and climate change	- evaluating the effectiveness of international protocols and treaties such as Kyoto (1997), the United Nations Framework Convention on Climate Change (since 1992) and the Washington Declaration (2007)

Earth and Space science Year 10 (Also above)	Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere	- investigating how human activity affects global systems - modelling a cycle, such as the water, carbon, nitrogen or phosphorus cycle within the biosphere - explaining the causes and effects of the greenhouse effect investigating the effect of climate change on sea levels and biodiversity - considering the long-term effects of loss of biodiversity - investigating currently occurring changes to permafrost and sea ice and the impacts of these changes - examining the factors that drive the deep ocean currents, their role in regulating global climate, and their effects on marine life

Year 10 Earth and Space science	Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community	- considering the role of science in identifying and explaining the causes of climate change
	Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries	- considering how computer modelling has improved knowledge and predictability of phenomena such as climate change and atmospheric pollution
	People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE194)	- considering the scientific knowledge used in discussions relating to climate change

Global change 1X

Year 9 History	The short and long-term impacts of the Industrial Revolution, including global changes in landscapes, transport and communication	- describing the impact of factories, mines and cities on the environment, and on population growth and distribution

Greenhouse 1X

Year 10 science	Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere	- explaining the causes and effects of the greenhouse effect

Carbon 12X (12 mentions with links to teaching climate change)

Science rationale	Initially, students identify the observable components of a clearly identified 'whole' such as features of plants and animals and parts of mixtures. Over Years 3 to 6, they learn to identify and describe relationships between components within simple systems, and they begin to appreciate that components within living and non-living systems are interdependent. In Years 7 to 10, they are introduced to the processes and underlying phenomena that structure systems such as ecosystems, body systems and the carbon cycle. They recognise that within systems, interactions between components can involve forces and changes acting in opposing directions and that for a system to be in a steady state, these factors need to be in a state of balance or equilibrium. They are increasingly aware that systems can exist as components within larger

	systems, and that one important part of thinking about systems is identifying boundaries, inputs and outputs.
Technology glossary	Carbon footprint The environmental impact of an individual or organisation's operation, measured in units of carbon dioxide. It includes primary emissions (the sum of the direct carbon dioxide emissions of fossil fuel burning and transportation such as cars and planes) and secondary, or indirect, emissions associated with the manufacture and breakdown of all products, services and food an individual or organisation consumes.

Year Level	Content	Elaboration
Unit 2 changing nations Year 8 Geography	Causes and consequences of urbanisation, drawing on a study from Indonesia, or another country of the Asia region	- examining how urbanisation can positively or negatively affect environmental quality (for example, carbon emissions and water consumption)
Year 9 design and technologies	Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved	- explaining how product life cycle thinking can influence decision-making related to design and technologies, for example rethinking products to provide for re-use, --

		selecting a material for a product that has a lower carbon footprint
	Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions	- exploring the ways commercial enterprises respond to the challenges and opportunities of technological change, for example e-commerce, and carbon footprint
	Work flexibly to effectively and safely test, select, justify and use appropriate technologies and processes to make designed solutions	- using materials, components, tools, equipment and techniques safely and considering alternatives to maximise sustainability, for example using timber because it stores carbon and offsets the demand for alternative products
Year 10 science	Values and needs of contemporary society can influence the focus of scientific research	- investigating technologies associated with the reduction of carbon pollution, such as carbon capture
	Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere	- modelling a cycle, such as the water, carbon, nitrogen or phosphorus cycle within the biosphere

Human activity 18X (11 mentions with links to teaching climate change)

Science Overview Rationale	In addition to its practical applications, learning science is a valuable pursuit in its own right. Students can experience the joy of scientific discovery and nurture their natural curiosity about the world around them. In doing this, they develop critical and creative thinking skills and challenge themselves to identify questions and draw evidence-based conclusions using scientific methods. The wider benefits of this 'scientific literacy' are well established, including giving students the capability to investigate the natural world and changes made to it through human activity.
Science Overview Structure Earth and space sciences	The earth and space sciences sub-strand is concerned with Earth's dynamic structure and its place in the cosmos. The key concepts developed within this sub-strand are that: Earth is part of a solar system that is part of a larger universe; Earth is subject to change within and on its surface, over a range of timescales as a result of natural processes and human use of resources. Through this sub-strand, students view Earth as part of a solar system, which is part of a galaxy, which is one of many in the universe, and explore the immense scales associated with space. They explore how changes on Earth, such as day and night and the seasons, relate to Earth's rotation and its orbit around the sun. Students investigate the processes that result in change to Earth's surface, recognising that Earth has evolved over 4.5 billion years and that the effect of some of these processes is only evident when viewed over extremely long

	timescales. They explore the ways in which humans use resources from Earth and appreciate the influence of human activity on the surface of Earth and its atmosphere.	
Year 4 Achievement Standard	By the end of Year 4, students apply the observable properties of materials to explain how objects and materials can be used. They describe how contact and non-contact forces affect interactions between objects. They discuss how natural processes and human activity cause changes to Earth's surface. They describe relationships that assist the survival of living things and sequence key stages in the life cycle of a plant or animal. They identify when science is used to understand the effect of their actions	
Year Level	Content	Elaboration
Year 1 HASS	Draw simple conclusions based on discussions, observations and information displayed in pictures and texts and on maps	- imagining what the future may hold based on what they know of the past and present (for example, envisioning what the town they live in might look like in the near future by comparing photographs of the past with their observation of the

		present) or envisaging how an environment might change due to human activity (such as when a new planting of street trees grow)
Earth AND Space sciences Year 4	Earth's surface changes over time as a result of natural processes and human activity	
Science as a human endeavour Use and influence of science Year 4	Science knowledge helps people to understand the effect of their actions	- exploring how science has contributed to a discussion about an issue such as loss of habitat for living things or how human activity has changed the local environment considering how to minimise the effects of erosion caused by human activity
Biological sciences Year 7	Interactions between organisms, including the effects of human activities can be represented by food chains and food webs	- investigating the effect of human activity on local habitats, such as deforestation, agriculture or the introduction of new species

Science as a human endeavor Year 7 Use and influence of science	Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations	- considering how human activity in the community can have positive and negative effects on the sustainability of ecosystems
Year 9 Science as a human endeavor	People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities.	- considering the impacts of human activity on an ecosystem from a range of different perspectives
Earth and space science Year 10	Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere	- investigating how human activity affects global systems

Adaptation 39x (2 mentions with links to teaching climate change)

Technologies glossary	Biomimicry An inspiration of functions found in nature for use and adaptation in the design of a *product*, *service* or *environment* or to solve human problems. For example, velcro fastening was inspired by small hooks on the end of burr needles. Termite mounds that maintain a constant temperature through air vents inspired architects to *design* cooling for buildings	
Design and Technologies Year 10	Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions	- considering how creativity, innovation and enterprise contribute to how products, services and environments evolve, for example how designers use biomimicry, the ways plant and animal adaptations can be copied to solve human challenges, such as the Japanese building Sendai Mediatheque based on seaweed-like tubes

Resilience 11X (2 mentions with links to teaching climate change)

Health and Physical Education Glossary	Resilience A capacity to deal constructively with *change* or challenge, allowing a person to maintain or re-establish their social and emotional wellbeing in the face of difficult events. It involves thoughts, feelings and actions. *Resilience* is an integral part of learning as it underpins the ability to *respond* positively to setbacks or mistakes.
	Wellbeing A sense of satisfaction, happiness, effective social functioning and *spiritual health*, and *dispositions* of optimism, openness, curiosity and *resilience*

Mitigation 6X (5 mentions with links to teaching climate change)

HASS F-6/7 Glossary	Prevention, Mitigation, Preparedness In geography, *prevention and mitigation* are actions taken in advance to decrease or eliminate an impact of a hazardous event on people, communities and the *environment*, by actions including, for example, lessening a hazard and reducing a vulnerability of a community. *Preparedness* refers to actions taken to create and maintain a capacity of communities to respond to, and recover from, natural disasters, through measures like planning, community education, information management, communications and warning systems.
Geography Glossary y7-10	Prevention, Mitigation, Preparedness Actions taken in advance to decrease or eliminate the impact of a hazardous event on people, communities and the *environment*, by actions including, for example, lessening the hazard and reducing the vulnerability of a community. Preparedness refers to actions taken to create and maintain a capacity of communities to respond to, and recover from, natural disasters, through measures like planning, community education, information management, communications and warning systems

Year Level	Content	Elaboration
Geography Year 5	The impact of bushfires or floods on environments and communities, and how people can respond	- researching how the application of principles of prevention, mitigation and preparedness minimises the harmful effects of bushfires or flooding
Year 8 Geography	Causes, impacts and responses to a geomorphological hazard	- researching how the application of principles of prevention, mitigation and preparedness minimises the harmful effects of geomorphological hazards or bushfires

Anthropogenic 0X

Appendix B

Survey

1. What is your gender?

○ Male

○ Female

2. Which category below includes your age?

○ 18-24

○ 25-34

○ 35-44

○ 45-54

○ 55-64

○ 65 or over

3. What is the highest level of education you have completed?

- Bachelor degree
- Graduate certificate
- Masters
- Doctorate
- Other (please specify)

4. How many years teaching experience do you have?

- 0-5 years
- 6-10 years
- 11-15 years

over 15 years

5. What year level/s do you currently teach?

6. What are your main teaching areas? (e.g.: Senior Primary; Junior High School Science; Grade 5)

7. In what region do you teach? (e.g.: Far North Queensland)

The survey is divided into two sections. The first section is interested in your personal responses and opinions relating to Climate Change at this moment in time and is not necessarily related to your professional opinion on teaching or learning.

8. How much do you feel you know about climate change? (1) a lot (6) nothing

(1) A lot (2) (3) (4) (5) (6) Nothing

*

9. Please indicate whether you think the following statements are true or false. If you do not know, just answer "Don't Know"

	True	False	Don't Know
The projected sea level rise provided by the IPCC (Intergovernmental Panel on Climate Change) for the remainder of the century (2099) is between 18 - 59cms.	○	○	○
Australia is one of the most exposed nations with respect to projected impacts of climate change.	○	○	○
Climate change will increase the risk in Australia for diseases transmitted by water and mosquitoes over the next 100 years.	○	○	○
Globally, the current burning of fossil fuels accounts for 80-85% (CO2) emissions added to the atmosphere.	○	○	○
Climate change is mainly caused by the hole in the ozone layer.	○	○	○
Australia produces about 5.5% of the planet's carbon emissions.	○	○	○
Australia's average temperature has increased by approximately 1C from 1910 - 2002.	○	○	○
The number of weather related disasters around the world has doubled since the mid 1990's.	○	○	○

10. How certain are you about the correctness of the answers you have given to the above true/false statements? (6) certain and (1) uncertain.

(6) Certain	(5)	(4)	(3)	(2)	(1) Uncertain

11. To what extent do you agree or disagree with each of the following statements about climate change?

	Strongly agree	Tend to agree	Neither agree nor disagree	Tend to disagree	Strongly disagree	No opinion	Don't know
I am certain climate change is really happening.							
There are risks to people in Australia from climate change.							
I have strong opinions about climate change.							

	Strongly agree	Tend to agree	Neither agree nor disagree	Tend to disagree	Strongly disagree	No opinion	Don't know
My emotions relating to climate change are quite strong.							
The seriousness of climate change is exaggerated.							
Most scientists agree that humans are causing climate change.							

12. How serious a problem do you think climate change is right now?

(6) Very serious (5) (4) (3) (2) (1) Not serious at all

13. Please select the response that best indicates your level of agreement for each statement below.

	(6) Strongly agree	(5)	(4)	(3)	(2)	(1) Strongly disagree
I believe my actions have an influence on climate change.						
I believe my actions have a positive influence on how I am feeling and thinking about climate change and environmental problems generally.						
My actions to reduce the effects of climate change in my community will encourage others to reduce the effects of global warming through their own actions.						
Human beings are responsible for global warming and climate change.						
Humans have little control over the forces of nature such as climate change.						

	(6) Strongly agree	(5)	(4)	(3)	(2)	(1) Strongly disagree
I believe that climate change is inevitable, no matter what we try and do to stop it.	○	○	○	○	○	○

14. How much do you trust what different sources say about climate change?

	(6) Completely	(5)	(4)	(3)	(2)	(1) Not at all
Scientists	☐	☐	☐	☐	☐	☐
Media	☐	☐	☐	☐	☐	☐
Government	☐	☐	☐	☐	☐	☐

15. How much information provided in the stories written and broadcast by news organisations about climate change would you say is accurate?

○ (6) Most of it ○ (5) ○ (4) ○ (3) ○ (2) ○ (1) Very little of it

16. How closely are you following news about the environment these days?

○ (6) A great deal ○ (5) ○ (4) ○ (3) ○ (2) ○ (1) Not at all

17. Please select an appropriate answer

I mostly inform myself about climate change through:

- ☐ Television news programs
- ☐ Television documentaries or movies
- ☐ Printed newspapers
- ☐ Online news websites
- ☐ Academic journals

Other (please specify)

18. Thinking about climate change, which, if any, of the following best describes your opinion?

- Climate change is entirely caused by natural processes.
- Climate change is mainly caused by natural processes.
- Climate change is partly cause by natural processes and partly cause by human activity.
- Climate change is mainly caused by human activities.
- Climate change is caused entirely by human activities.
- I think there is no such thing as climate change.
- Don't know
- No opinion

The final part of the survey is related to your PROFESSIONAL views on Education and Climate Change.

19. To what extent do you agree or disagree with the following statements about climate change education?

	Strongly agree	Tend to agree	Neither agree no disagree	Tend to disagree	Strongly disagree	No opinion	Don't know
Climate change education means solely teaching students about the science of climate change.							
Climate change education involves students understanding how human use of CFC's has damaged our climate.							
Climate change education involves many complex issues including human rights and injustice.							
Climate change education should encourage students to think about their own beliefs and values.							

	Strongly agree	Tend to agree	Neither agree no disagree	Tend to disagree	Strongly disagree	No opinion	Don't know
Climate change education should aim to change the way people behave.	○	○	○	○	○	○	○
Climate change education includes encouraging students to be critical thinkers and problem solvers.	○	○	○	○	○	○	○
Adaptation to climate change is an important element of climate change education.	○	○	○	○	○	○	○
Climate change education should be focused on how to stop or slow down climate change.	○	○	○	○	○	○	○
Climate change education should primarily focus on scientific understandings.	○	○	○	○	○	○	○

	Strongly agree	Tend to agree	Neither agree no disagree	Tend to disagree	Strongly disagree	No opinion	Don't know
Climate change education should include 'both sides' of the debate equally.	◯	◯	◯	◯	◯	◯	◯
Climate change education should make students aware of the controversy surrounding climate change.	◯	◯	◯	◯	◯	◯	◯
Only one 'side' of climate change (that it is happening and humans are the cause) should be taught to students.	◯	◯	◯	◯	◯	◯	◯

20. In your own words what does climate change education involve?

21. To what extent do you agree or disagree with the following statements about climate change education?

	Strongly agree	Tend to agree	Neither agree no disagree	Tend to disagree	Strongly disagree	No opinion	Don't know
Climate change is too controversial to be discussed in classrooms.							
I believe climate change education is the role of all teachers.							
Climate change education is solely the responsibility of science teachers.							
Climate change education provides an opportunity to discuss world issues with my class.							
Climate change education is a high priority within my school.							

	Strongly agree	Tend to agree	Neither agree no disagree	Tend to disagree	Strongly disagree	No opinion	Don't know
Climate change education is a high priority for me.							
It is not the role of school to teach students about climate change.							
I feel I have the knowledge and skills needed to teach climate change education to my students.							
I would like to include climate change education within my class but feel parents would not be supportive.							
Climate change education is not appropriate for schools.							

22. Thinking about climate change and climate change education, which ONE of the following best describes your opinion?

- Climate change education is a high priority for me.
- Climate change education is a priority for me.
- Climate change education is neither a high or low priority for me.
- Climate change education is not a priority for me.
- Climate change education has no place in my classroom.

23. Thinking about climate change education:

What would you describe as having an influence on your teaching and curriculum choices to INCLUDE climate change education?

	(6) A great deal	(5)	(4)	(3)	(2)	(1) Not at all
Personal interest in topic.	○	○	○	○	○	○
School community pressure.	○	○	○	○	○	○
School Principal.	○	○	○	○	○	○
Student interest.	○	○	○	○	○	○
Student ability levels.	○	○	○	○	○	○
Students' personalities and maturity.	○	○	○	○	○	○
Personal beliefs about the importance of the topic.	○	○	○	○	○	○

	(6) A great deal	(5)	(4)	(3)	(2)	(1) Not at all
Personal beliefs about the role of education.	◌	◌	◌	◌	◌	◌

24. Thinking about climate change education:

What would you describe as having an influence on your teaching and curriculum choices to EXCLUDE climate change education?

	(6) A great deal	(5)	(4)	(3)	(2)	(1) Not at all
Personal interest in topic.	◌	◌	◌	◌	◌	◌
School community pressure.	◌	◌	◌	◌	◌	◌
School Principal.	◌	◌	◌	◌	◌	◌
Student interest.	◌	◌	◌	◌	◌	◌
Student ability levels.	◌	◌	◌	◌	◌	◌

	(6) A great deal	(5)	(4)	(3)	(2)	(1) Not at all
Students' personalities and maturity.	○	○	○	○	○	○
Personal beliefs about the importance of the topic.	○	○	○	○	○	○
Personal beliefs about the role of education.	○	○	○	○	○	○

25. Thinking about climate change education, what would you describe as having the greatest influence on your teaching and curriculum decisions?

26. How (if at all) have you included climate change education in your classroom in the past?

Thank you for your time and your thoughtful responses. This is the final page of the survey.

27. Do you have any further comments you would like to add on this topic? Is there anything that was touched on that you feel you would like to say more about?

28. You are also invited to take part in follow-up interviews. A small number of respondents will be asked to clarify and expand upon responses and ideas. Those who agree and are contacted will be invited to meet with the researcher (either in person, via Skype or telephone) to discuss some questions in more detail. All responses will be anonymous and your identity, the identity of your school, or any other identifiable information will be kept confidential.
In the case of agreeing to take part in the interviews your questionnaire results will not remain anonymous to the researcher, however, your responses will remain confidential. The interview, with your consent, will be audio-taped, and should only take approximately 1 hour of your time. The interview will be conducted at James Cook University, or a venue of your choice. Your responses during interviews will remain confidential and it is not the purpose of this research to identify individual teachers or schools.
This research is an important step in developing an understanding of what teachers believe about the importance and place of climate change education within the school curriculum.

If you consent to the researcher contacting you please leave your NAME and EMAIL ADDRESS below.

Thank you for your time.

CONSENT

I understand the aim of this research project is to investigate Queensland teachers' beliefs about climate change education. I consent to participate in this project, the details of which have been explained to me.

I understand that my participation will involve answering a questionnaire, and I agree that the researcher may use the results as described in the information sheet.

I acknowledge by submitting my response that I agree:

- that once I have submitted my questionnaire I can no longer remove my responses from the data pool unless I have supplied my contact details;

- that any information I give will be kept strictly confidential and that no names will be used to identify me with this study without my approval;

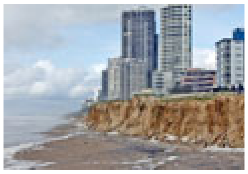
- if I consent to further participation within this study I will leave my contact details at the end of the questionnaire.

- I am aware that taking part in the questionnaire and follow-up interview is voluntary and I am aware I can stop taking part in this study at any time without explanation or prejudice.

Appendix C

QCT e-News Survey Advertisement text

Contribute to New Research: Does Climate Change Education have a place in Australian classrooms?



Teachers' perspectives are important and climate change education is a complex issue. Researchers at James Cook University are investigating teachers' perspectives on climate change education. Responses are sought from **diverse perspectives**. Whether you feel strongly or are indifferent about climate change education, your opinions are important.

The online survey can be found by clicking the following link:

www.surveymonkey.com/s/climatechangeeducation

- All online survey responses are **anonymous**
- The online survey will take approximately **10 minutes** to complete
- You may provide responses via the phone, email or Skype

If you would like more information please contact principal researcher Jennifer Nicholls (jennifer.nicholls@my.jcu.edu.au) at James Cook University's School of Education.

Appendix D

Interview question prompts

IMPORTANT – INCLUDE FOR EACH INTERVIEW

Thank you for agreeing to take part in this interview.

Firstly, before I start, I would like to record this interview for review later. Do you agree to this interview being recorded?

Thank you.

Before we commence I need to read to you a statement and when I am done can you please indicate whether you agree or disagree. The statement is relating to you agreeing to take part in this research,

I understand the aim of this research project is to investigate Queensland teachers' belief about climate change education and the inclusion of climate change education within various classroom settings. I consent to participate in this project.

I understand that my participation will involve an interview, and I agree that the researcher may use the results in future publications.

By verbally agreeing to take part in this research I acknowledge that:

- taking part in this study is voluntary and I am aware that I can stop taking part in it at any time without explanation or prejudice and to withdraw any unprocessed data I have provided;

- that any information I give will be kept strictly confidential and that no names will be used to identify me with this study without my approval;

Do you agree to take part in this research project?

Thank you.

**

Throughout the interview if you feel you do not wish to answer a question please indicate by stating no comment. If at any time throughout the interview you wish to stop please let me know.

1. To begin with can you please describe your current teaching context for example: The type of school you work in, What year level and or subjects do you currently teach? What other subject have you taught in the past?

Climate change:

CC1.

In this part of the interview I am going to ask you for your understanding of a few terms. The questions are not a test of what you know or don't know but these terms can be ambiguous to many people so I am interested in your interpretation of the terms. Please feel free to say as little or as much as you like.

2. When you hear 'Climate change' many images may come to mind. Could you first explain what you believe climate change to mean. (do you have any personal experiences that inform your description?)
3. Are there differences between global warming and climate change?
4. Are the differences between weather and climate?
5. Can you explain what is meant by the Greenhouse effect?
6. Do you believe there is a greenhouse effect?
7. How certain do you believe the science around climate change to be?
8. What types of science/scientists are looking at climate change?
9. Is climate change proven? Can it ever be?

Now I am going to ask you several questions relating to climate change.

The following questions are concerned with your personal beliefs and feelings about climate change and are not related to your professional opinions or education more generally. Some questions may feel as though they are repetitive as I need to cover everything. Please feel free to refer to a previous answer if you feel you have already answered the question in enough detail previously.

CC2.

Thinking about climate change:

Do you actively seek information about climate change?

Y- What prompts you to seek information?

N- What would prompt you to seek information?

Where would you/ do you look to find information about climate change?

Do you trust newspapers and radio to provide accurate information on the issue of climate change?

Who do you trust as a source of information about climate change?

Climate change is often presented as a debate. What do you think about the idea of debate and climate science?

CC3.

Can you list all of the causes of climate change that you can think of right now?

To what extent do you believe that the climate is changing due to human actions?

What are the other causes?

If Yes

What effects do you think climate change will have?

Do you think climate change will have any impact on Australia? How will climate change impact on Australia?

Will Climate change impact on you personally? How?

Do you think anything can be done to lessen these effects?

Do humans need to respond?

Who do you believe should be acting on climate change? (personally, local, state federal governments? Global community)

If No

Do you think the climate is changing at all?

Do you think humans have any influence on the climate?

Do you think humans need to respond to climate change (mitigation/adaptation)?

Why do you think climate change theory is being put forward by scientists and governments??

(Extend)

i.e. what do you think scientists are gaining from the climate change myth?

(Government etc.)

**Thinking about climate change can you identify any specific experiences that have influenced your thinking around this issue? For example a particular radio program you may have heard, an experience with family members, childhood science teachers.

Did this experience provide you with new information or reinforce previous understandings?**

Education:

This part of the interview is focussed on education and your beliefs as an education professional. As stated previously there are no right or wrong answers and I am interested in your beliefs about these topics.

The first question in this part of the interview is related to your beliefs about the purpose of education not necessarily related to climate change but more generally.

To begin with I would like to form an image of your thinking about education in general. This question may seem daunting but in your opinion what do you believe to be the role or purpose of education? (Your ideal vision and what the current purpose appears to be.)

CCE Mean E1.

1. When you hear the words 'climate change education' what do you think of?

E2

2. What do you think climate change education would look like? What types of things would be covered or included?

3. Do you think climate change education is appropriate within schools? (all year levels / which year levels)

Climate change practice E4/E2

4. Do you actively seek to include climate change education within your classroom/s?
5. Does climate change education have a place in your classroom?
6. Why do you include cc/why not?

If yes a) How do you include climate change education within your classroom/s?

b) Why? What made you or encourages you to include climate change education into your classroom/s (personal interest, student interest, school policy etc.).

E4

c) What or who supports your attempts to include climate change education? (prompts – Principal, other teachers, student enthusiasm, parents, resources, staff development, personal influences).

d) What do you see as some of the barriers you have faced in attempting to include climate change education within your classroom.

If no a) Why do you not include climate change education?

b) What would you say influences your decision the most? (Extend on answers provided here. Further development of this question may occur when survey responses are reviewed).

(This question will require prompts to encourage a deep reflection by teachers on their choices. Prompts will be devised once survey responses have been reviewed and possible answers to this question have been established)

c) Do you feel pressure from the 'school' (principal, staff; Community) to include climate change education?

d) Can you think of any occurrence that would or could change the way you feel about climate change education?

7. Is/are there any aspect/ideas/concepts relating to climate change that you would not teach?

E3.

8. This next question is focussed on influences on your teaching practice. Thinking about climate change in your school context and influences on your decision making about including climate change as part of a lesson or unit plan.

Firstly

a) IS the National curriculum an influence on your teaching and curriculum decisions?

b) How does curriculum document affect you decisions? (For example does it specifically state CC should be included or does the set document leave little space for you to include a topic you feel is important but not addresses?)
c) School administrative staff including the principal?
d) School community for example parents?
e) Other teachers?
f) Your own feelings and beliefs about the role of education?
g) Your role as a teacher?

9. Apart from science how else do you feel climate change could be included with in your curriculum (social, adaptation?)
10. How does the cross-curricular priority of sustainability influence your planning and teaching decisions?

11. Do you think it is important to appear neutral, for example give equal weight to all points of view when discussing climate change with students?

12. How should climate change science be presented to students, for example as solid reliable science or as one of many possibilities??

13. Reflecting on you own experiences can you think of anything that may have influenced your thinking about climate change education for example your own experiences as a student or family influences?

That is the last question for this interview is there anything you feel you would like to expand upon or anything you feel you were not given the opportunity to discuss that you would like to elaborate on now?

Thank you for your time. I appreciate you willingness to discuss this topic with me today. If you feel you have missed a point or would like to clarify anything that has been discussed today please email me and I would be happy to hear from you.

Appendix E

Queensland State School's Regional Map

Appendix F
Ethics approval

This administrative form
has been removed

This administrative form
has been removed