
Exploring the Effects of Climate Change
Communication and Training Efforts:
Lessons from Training-Courses aimed at Mid-
Career Professionals

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Abstract

Research on the different ways in which climate change and adaptation (CCA) is communicated and taught has been growing in popularity over the last few decades. Researchers in communication science have found that the way in which information is presented and transferred is important in influencing people's perceptions and attitudes towards particular topics and issues. With this in mind, the lack of interest or realization of the severity of climate change at many levels of governance may be indicative that climate change, the subsequent negative impacts thereof and the need to implement adaptive and mitigative strategies - is not being effectively communicated to these audiences.

This research explores the effect of CCA training-courses on participant knowledge, perceptions and attitudes towards CCA and related issues. It also highlights training methods and elements of course design which participants identified as enabling factors in enabling their understanding of CCA. The data collection used a mix methods approach, and focused around two training-courses. Participants (n=37) were mid-career professionals, many of whom engage in decision-making and policy development activities in different levels and sectors of government. Quantitative data was collected using scaled pre-and-post training tests. Qualitative data was collected through 14 semi-structured interviews, process observations, and anonymous feedback slips.

A majority of participants (68%), showed an increase in knowledge scores after attending training. Similarly, 62% of participants responded more positively to questions relating to CCA in the post-training test compared to their pre-test responses. This research did not find a strong correlation between changes in knowledge, and changes in perceptions and attitudes; however, there were positive changes in all three variables. Participants discussed six methods of teaching and training which enabled their understanding of CCA and related issues; namely, PowerPoint™ presentations, group work, practical exercises, games and role-play. Learnings from studying the training-courses highlight the importance of collaborative learning, diversity in participant groups, active engagement of participants with various mixed training methods and careful framing of content such that it inspires a sense of confidence rather than hopelessness.

The effective communication and transfer of CCA information to professionals that are engaged in decision-making and policy development is key to increasing adaptive capacity, and subsequently adaptation at scale. It is therefore critical that CCA communication and capacity building efforts, such as training-courses, are designed such that they optimize participant learning and understanding.

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Plagiarism Declaration

I know the meaning of plagiarism and declare that all of the work in the dissertation, save for that which is properly acknowledged, is my own.

Signed: _____ Date _____

1. Introduction

Around the world, government employees who are involved in decision-making and planning are encouraged to collaborate with scientists and scientific information as mankind faces one of the biggest challenges of our time, that of climate change. Many nations have developed or are currently developing and adopting National Adaptation Strategies (NAS) (Briesbroek et al., 2010). Yet even the most basic of facts around climate change (such as the phenomenon that global average temperatures are increasing) are confusing or vague to some decision-makers and planners (Hassol, 2008). Recognising that individuals who work in governance can play a key role in reducing the negative impacts of climate change, many adaptation strategies state the importance of clear messaging when communicating climate change and adaptation to these individuals (Briesbroek et al., 2010). It is therefore more important than ever that scientists be effective in the ways in which they communicate what they know (Hassol, 2008). The body of research pertaining to climate change and adaptation communication continues to grow, and consensus around anthropogenic climate change is also gaining in strength (Oreskes, 2004; Doran and Zimmerman, 2009). Perhaps as a result, countries, provinces, and multi-national organisations are funding bottom-up and top-down communication and training efforts (Stewart et al., 2009). While these efforts range in scale from local to global, not many empirical studies have been conducted which evaluate the effectiveness of different methods of communication and training (Moser, 2010a). This lack of research is even more prevalent in the global South (Moser, 2010a).

1.1 Building adaptive capacity in governance through training activities

Climate change and adaptation (CCA) training-courses generally aim to increase participant understanding of climate change and related issues, with the goal of building knowledge on climate change and its impacts, as well as adaptation strategies. The increase in knowledge on the topic builds adaptive capacity in individuals, which can in turn lead to an increase in adaptive capacity at an institutional level (Gupta, et al. 2010).

Climate change adaptation literature points to several key determinants for building and increasing adaptive capacity (Brooks et al., 2005; Adger, 2003; Yohe and Tol, 2002; IPCC, 2001). Among those, governance (i.e. the way in which different levels of government control and regulate the country) and institutional mechanisms are believed to be of particular importance (Brooks et al., 2005; Nelson et al., 2007; Engle and Lemos, 2010). However, building adaptive capacity in governance can require building capacity in multiple individuals who are engaged in decision-making activities. Studies show that on the individual level, knowledge, understanding, values and beliefs are critical antecedents to adaptive behaviour (e.g. Grothmann and Patt, 2005; Patt and Schroeter, 2008; Burch, 2010; Gifford, et al., 2011; Pasquini et al., 2013). One particular strategy of improving individual levels knowledge of climate change, and thereby addressing some degree of the individual level barriers to adaptation, is through encouraging individuals to participate in climate change and adaptation training-courses.

1.2 Methods for effective communication and training

Many authors (including Hertwig et al., 2004, 2006; Weber et al., 2004; and Wirth and Grothmann, 2014) argue that it is the way in which information is communicated and taught which can motivate people to adopt particular behaviour, and yet the body of research pertaining to how climate change and adaptation information is taught and communicated is limited. A study by Wirth and Grothmann (2014) analyzed 278 climate change and adaptation formats in 10 different countries, and found that how information is presented and communicated is extremely important in motivating people to take adaptation action (Wirth and Grothmann, 2014). Similarly, other studies have found that different methods of communication influence the way in which information is processed (e.g. Weber et al., 2004; Hertwig et al., 2004, 2006). This means that different communication methods are important determinants in triggering certain outcomes (such as behaviour), which can in turn have important impacts in terms of how key stakeholders make decisions.

In their literature review of the effectiveness of different climate communication strategies, Wolf and Moser (2011) highlight the need for more in-depth studies focused on understanding how different conditions enable or disable the learning process when it

comes to teaching and communicating content relating to climate change and adaptation. It is therefore worth exploring the respective merits and disadvantages of different training methods, since particular methods may be better suited than others for teaching and communicating this complex and important topic (Moser, 2010a; OXFAM, 2010).

Research relating to communication and training in building adaptive capacity in the African context in particular, is severely lacking. There are currently no peer-reviewed case-studies, which evaluate the effectiveness of climate change communication campaigns in the African context. There is a sizeable requirement for more research in the field of climate change communication and training, not only in terms of communicating effectively to government employees or decision-makers, but for all stakeholders and audiences who will inevitably be affected by the impacts of climate change. The amount of peer-reviewed literature supporting the physical science of climate change is massive, but this knowledge needs to be “translated” and communicated using appropriate and tailored methods. Further research is also needed to shed light on how different individuals, groups, and institutions react and process climate change information. In this way, the scientific community might be able to improve on the design of communication campaigns such that climate change information is applied and used. This thesis contributes to the broader literature of building adaptive capacity to climate change, by identifying the effects of training-courses on participant knowledge and perceptions of, and attitudes towards climate change, whilst identifying methods of communication and training, which enables learning.

1.3 Research aim and objectives

The aim of this thesis is to better understand the overall effect of climate change and adaptation training-courses on participants who attend such courses, whilst highlighting training methods and elements of course design that enable understanding of and engagement with the topics of climate change and adaptation.

In order to achieve this aim, the following objectives were identified:

1. Determine whether or not attending a climate change training-course results in improved knowledge of climate change and related issues.
2. Explore the effect of a climate change training-course on participant perceptions of and attitudes towards climate change and related issues.
3. Determine whether there is a relationship between knowledge of climate change, and participant's perceptions and attitudes towards climate change and related issues.
4. Investigate methods of communication and training that are most effective in enabling participants to understand climate change information.

1.4 Thesis Outline

The following chapter provides a review of relevant literature and explanation of the conceptual approach. Following this, the methodology chapter provides a description of the data collection and analysis procedures used to accomplish the objectives of this thesis. The fourth chapter shows the results achieved through data collection and analysis, and is followed by a discussion chapter. The thesis is concluded and recommendations for future work are stipulated in the sixth and final chapter.

2. Literature Review

This chapter provides a review of key literatures pertaining to the concepts and theories that frame the research question identified in the previous section. Climate change is thought to be an interdisciplinary field of research, i.e. it is dependent on the knowledge, skills, and contributions of people from a variety of different disciplines (Hadorn et al. 2008). Furthermore, researchers who work on climate change are increasingly arranging themselves into interdisciplinary teams, centres and networks, whilst organisations that fund research are calling for more and improved collaboration between scientists and social scientists (Olsen et al. 2013). With these points in mind, this thesis refers to and draws on research from multiple disciplines, identifying and applying relevant literature at different stages to explore the research question through a multidisciplinary lens.

This chapter begins by exploring the existing literature on communication in the field of climate change and adaptation. Following this, the concept of capacity building is introduced. The next section introduces literature from cognitive psychology, and explores how different methods of training can activate different cognitive processing systems in the brain. Two cognitive processing systems, the analytic and experiential, are explained in more detail. Following this, literature from the field of education pertaining to different methods of teaching and training are coupled with concepts from cognitive psychology. Ways in which climate change and adaptation training-courses can be designed to maximise learning and knowledge transfer to the workplace are then explored. Following this, the relationship between effective learning and its potential to influence one's perceptions and attitudes is explored. The final section of this chapter outlines the conceptual approach.

2.1 Communication in the field of climate change and adaptation

According to the online Oxford Dictionary, the word communication means “The imparting or exchanging of information by speaking, writing, or using some other medium”, or “the science and practise of transmitting information” (Oxford, 2016). These two definitions show the link between communication and teaching, since teachers are constantly imparting new knowledge and transmitting information. This thesis situates the study of

climate change and adaptation (CCA) training-courses within the broader field of climate change and adaptation communication.

Anthropogenic climate change first emerged on the public agenda in the mid-to-late 1980s mostly focusing on scientific findings, synthesis reports, and high-level conferences (Weart, 2003). Once the seriousness of the situation was eventually realised, those with a direct stake in maintaining a carbon-heavy status-quo were loud spokespersons against the science upon which climate change is based, and the contested need for mitigation policies (McCright, 2001). These spokespersons employed unqualified scientists, created think tanks which produced misleading messages, and channelled their efforts through the loud voice of mass media. They also used the solicitation of politicians to create and spread the idea that the science supporting anthropogenic climate change was inadequate (Cox, 2006). On the other hand, those who were convinced of anthropogenic climate change took on the task of raising awareness, and attempted to increase understanding and advocate for policy change (Moser and Dilling, 2007). Mass media outlets played a big role in the way in which climate change was framed in the public realm, reporting on and exaggerating the resulting climate change discourse as a “battle” of the sciences (Boykoff, 2007, pg 1192). As the cycles of the media turned their attention to different issues and followed this so-called “battle”, so awareness and perceptions of climate change changed (Brossard et al., 2004).

Today, more than 20 years later, the scientific consensus around anthropogenic climate change is much greater and media is reporting on climate change much frequently (Oreskes, 2004; Doran and Zimmerman, 2009; Schmidt et al. 2013). Public awareness has also improved, with a number of countries, provinces, and multinational organisations having introduced top-down climate change communication campaigns (e.g. Japan, United Kingdom, Canada, Victoria in Australia, and California in the United States of America, as well as the European Union and the United Nations Development Program) (Moser, 2010b). There are also many large bottom-up campaigns, for example those initiated by international non-governmental organisations such as OXFAM (Moser, 2010a; OXFAM, 2010). The academic field of climate change communication has similarly grown and advanced. However, this growth has not come from the long-standing field of communication studies. Rather, advancement has emerged somewhat organically as a

result of a pressing need perceived by those directly involved in communicating the issue (Moser, 2007; Whitmarsh et al., 2010).

The successful communication of climate change information is usually complicated, not only because of the complex science behind the phenomenon, but also because of the associated uncertainties (Marx et al., 2007). Climate change communication efforts have historically aimed to convince policymakers that anthropogenic climate change is a real, pressing issue. Although scepticism does still exist, there is now stronger consensus amongst scientists and policymakers than previously existed (IPCC, 2007). Communication efforts have thus followed suit and are less focused on persuasion that climate change is a legitimate concern, and more focused on trying to engage policymakers such that they might adopt practical measures to reduce the scale of change and deal with the impacts thereof (Nerlich, Koteyko, and Brown, 2010).

2.2 Communication and training to build adaptive capacity

Adaptation is essential to avoid and reduce the negative impacts of climate change, especially in the developing world (Commission on Climate Change and Development, 2009). The IPCC defines adaptation to climate change for human systems as:

“The process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities”

(IPCC, 2012, p.556)

Communication and training efforts, such as CCA training-courses, can be implemented with the aim of building adaptive capacity, and thereby inspiring adaptation (CSAG, 2016). Adaptive capacity is defined by the IPCC (2012, p.556) as “the combination of strengths, attributes, and resources available to an individual, community, society, or organisation that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities associated with climate change”. This thesis draws on this definition, recognising that a system’s capacity to adjust to climatic stressors is interlinked to its capacity to adjust to environmental, social, economic and political

challenges within the system (Brooks, 2003; Smit and Wandel, 2006; Marshall et al., 2009; Yohe and Tol, 2002).

A study by Pasquini et al. (2013) investigated barriers to action on climate change adaptation in eight municipalities in the Western Cape Province of South Africa. The authors found that there are a number of barriers that affect the ability of municipalities to mainstream adaptation issues. Identified barriers include; individual-level barriers, regulatory/institutional barriers, and socio-cultural barrier (Pasquini et al. 2013). This thesis focuses on individual-level barriers, which includes a lack of understanding of climate change and adaptation choices at an individual scale. Pasquini et al. (2013) explain that individual-level knowledge; understanding, values and beliefs are critical antecedents to behaviour (e.g. Burch, 2010; Gifford, et al., 2011; Grothmann and Patt, 2005; Patt and Schroeter, 2008). Adger et al. (2005) describe the communication of climate change information, and the building of awareness of the potential impacts of climate change as actions associated with building adaptive capacity. Therefore, in order to address the individual-level barrier to adaptation identified by Pasquini et al. (2013), it is necessary to build capacity on an individual's level.

2.3 Building adaptive capacity by maximizing knowledge transfer through training

Much of the literature from the field of organizational training that can be applied to climate change training-courses. Organizational training theory has found that an aspect of training too often forgotten in communication and training efforts is the ability of individuals to apply the information and skills learnt at training-courses, to their respective workplaces (Marsick and Watkins, 2015). Although studies on the barriers to adaptation at institutional and organizational levels have been conducted (e.g. Measham et al. 2011, Pasquini et al. 2013, Lawrence et al. 2015), not much has been achieved to incorporate the large body of existing literature on organization training, to the realm of climate change and adaptation training. There is potentially much to be gained in applying lessons learnt from organizational training, to the design of climate change and adaptation training-courses. For instance, there is literature that pertains to the applicability of training-course content to the workplace (e.g. Alvarez et al., 2004). This literature, if applied to climate change and

adaptation training-courses, could help increase individual's information uptake and their ability to transfer and apply their newly learnt knowledge when making decisions at the workplace, thus increasing adaptive capacity.

Literature on the transfer of training to the workplace has revealed three main influences on transfer: the training design, such as the methods of instruction, the instructors themselves, and tools of communication used (e.g. Alvarez et al., 2004); the trainee characteristics such as cognitive ability, locus of control, conscientiousness, motivation, anxiety and self-efficacy (e.g. Chiaburu and Tekleab, 2005; Colquitt et al., 2000; Ford et al., 1998; Mathieu et al., 1992; and the work environment, which includes variables in the organisational culture and climate dimensions, such as the continuous learning culture (Tracey et al., 1995). Although all three of these elements are important in influencing transfer, the scope of this thesis is not broad enough to cover all of them. This thesis explores the first factor, training design – by exploring the elements of course design that enabled participant understanding of the content.

2.4 Learning and Cognitive Processing Systems: Analytic and Experiential

Analytic processing is related to careful, logical thought and occurs when current situations relate to processed ensembles of relevant events that took place in the past (Stanovich and West, 1998). Analytic information is understood best when translated into tangible images, compelling emotions, or narrative (Marx et al., 2007). Experiential processing on the other hand, is generally faster than analytic, and is closely associated with affect and emotions.

Analytic and experiential processing systems can work together in interesting ways, especially when analytic processing used to modify how people categorize their current situations, relative to experiences they have had in the past. A number of authors have looked at how people process information when a combination of analytical and experiential information is provided (e.g. Birnbaum and Mellers, 1983; Tversky and Koehler, 1994; Jenni and Loewenstein, 1997; Clemen and Winkler, 1999; Kraemer and Weber, 2004; Fagerlin et al., 2005). Generally speaking, researchers have found that experiential information overpowers analytical information unless the analytical information is

translated into visual, narrative, or other formats which are easily combined with personal experience (Marx et al., 2007). When concepts are communicated using very analytical information alone e.g. using high-level concepts, such as sample size, relative frequency, or probability, the information tends to be ignored because this type of information cannot easily be envisaged accurately (Marx et al. 2007).

Experiential cognitive processes are activated through experiential learning. Kolb (1984) was the first to introduce the theory of experiential learning, and created a model (Figure 1) which illustrates the learning cycle that is activated through experiential learning. As is illustrated in Figure 1, experiential learning takes place when one can relate ones current situation to memories of an experience (this can be one's own or someone else's experience).

The power of experiential learning is that a person does not necessarily have to have experienced a situation personally in order for it to trigger experiential processes in the brain – since a sufficiently vivid description allows listeners and readers to actually place themselves in the story (Marx et al. 2007). Furthermore, events that have taken place in the past can often induce strong emotions, which frequently makes one remember them, and therefore dominate when information is being processed (Slovic et al., 2002; Loewenstein et al., 2001).

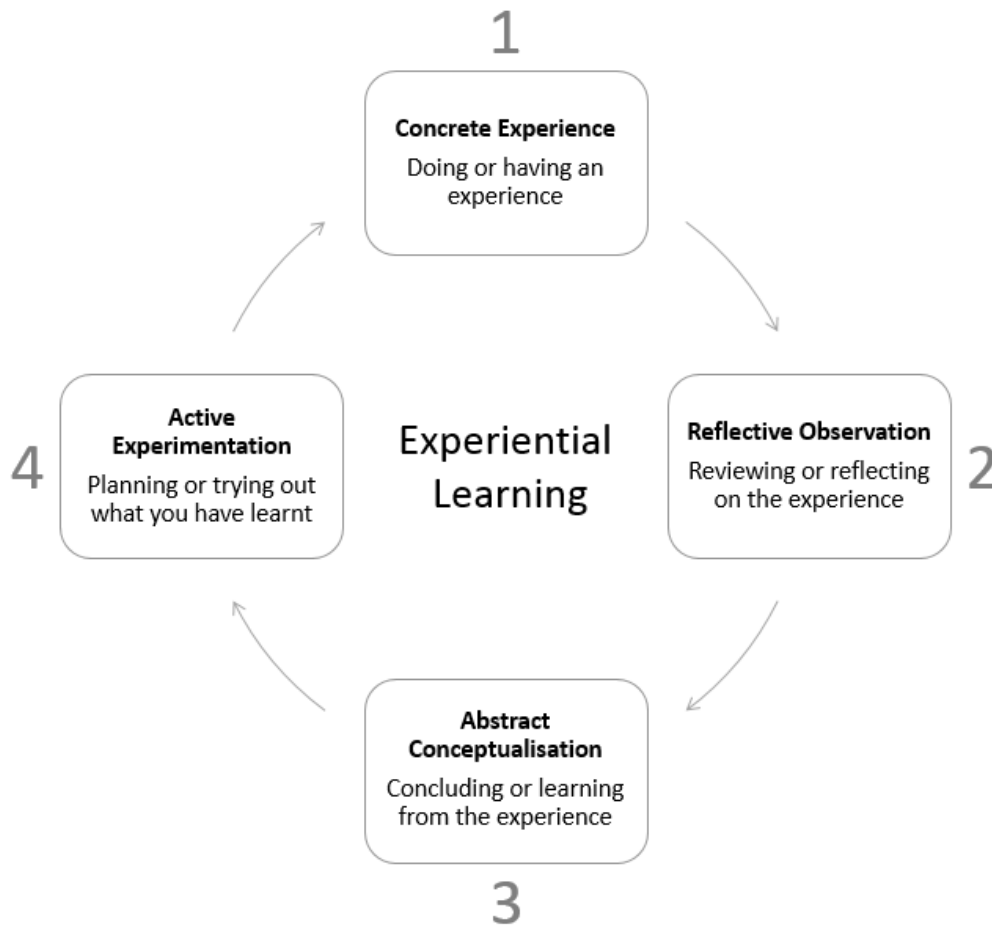


Figure 1: Kolb's experiential learning theory states that effective learning takes place when a person progresses through a cycle of four stages: of (1) having a concrete experience followed by (2) observation of and reflection on that experience which leads to (3) the formation of abstract concepts (analysis) and generalizations (conclusions) which are then (4) used to test hypothesis in future situations, resulting in new experiences (Kolb, 1984).

2.5 Methods of training and the activation of different cognitive processing systems

The way information is communicated and taught influences the way in which information is processed. This means that different communication methods are important determinants in terms of triggering certain outcomes (Hertwig et al., 2004, 2006; Weber et al., 2004). Moser (2010) argues that different modes and channels of communication differentially affect the persuasiveness of scientific communication. Following on this discourse, others such as Pidgeon and Fischhoff (2011) argue that depending on how climate change information is communicated; it can fuel both disbelief as well as fatalistic acceptance of climate related changes. It is therefore worth exploring the different ways in

which climate change information is communicated, and the subsequent cognitive effects of these different communication methods.

Table 1: Differences between Experiential and Analytic Cognitive Processing Systems (from Chaiken and Trope, 1999, and Sloman, 1996).

Two Processing Systems	
Experiential	Analytic
Operations on personal memories	Operations on sets of ensembles
Casual schemes	Logical rules
Vivid images	Abstract symbols
Strong affective component	Often deliberative

There is a well-established body of literature in cognitive psychology concerning the way in which information is processed and the ability of different communication methods to trigger particular cognitive processes (see Chaiken and Trope, 1999 for a comprehensive review; see Hertwig et al., 2004, 2006; Weber et al., 2004; Marx et al. 2007 and; Moser, 2010 for examples). A paper by Marx et al. (2007) is one of few that brings together theory on cognitive processes, with that of climate change communication.

Researchers have known for a long time that when people are given a choice to make, and have the opportunity to base that choice on abstract statistical evidence or concrete personal experience, abstract statistical evidence is less likely to be used (Hertwig et al., 2004, 2006; Weber et al., 2004). Marx et al. (2007), on the other hand, argue that both experiential and analytic processing systems should be considered when designing climate change communication and training strategies. When a person experiences something, the experiential processing system is activated. This means that a person reflects on their experience, and something is learnt from that experience. The effect of this new understanding can be a motivator of action. On the other hand, analytical information that is processed by the analytic system has an output that has less weight in actions or decisions (Marx et al. 2007).

Therefore, if purely analytical processing is targeted when designing CCA communication and training strategies, the information may fall on deaf ears as decision-makers may continue to rely on their own and others' personal experiences when planning for the future. Marx et al. (2007) argue that, rather than relying on traditional methods of communication and training, which rely on triggering analytic processes in one's cognition, a better understanding of experiential processing and subsequent application may lead to better communication (Marx et al. 2007; Chaiken and Trope, 1999). Further to this argument, it is important to be aware that there is no sharp divide between experiential and analytic processing. However, in communication efforts the role of analytic processing is often overestimated whilst experiential processing is often ignored (Marx et al. 2007). The real challenge is to find ways to communicate that are creative such that they engage both systems (Marx et al. 2007).

2.6 Designing communication and training strategies to activate both processing systems

If the theory of analytic and experiential processing systems, outlined above, is applied to CCA communication and training efforts, a combination of analytic and experiential information might be incorporated into training in interactive and engaging ways. One way to integrate the two might be through group and participatory decision-making activities. The group should ideally be made up of individuals with a range of knowledge, personal experience, and skills such that they are able to share a diverse range of information and perspectives to come up with solutions to problems. Ideally, groups should include at least one member who is trained at reading analytic information such that both analytic and experiential information is understood and may be used in the decision-making process (Marx et al. 2007).

Climate change is a complex issue, and there is no one-size-fits-all solution in terms of the best way to communicate it to people. However, the field of climate change communication has grown in diversity with research focusing on messaging, language, imagery, messengers, communication modes, media, and audience segmentation (Moser, 2015). Nonetheless, much of the climate change communication methods and strategies are not interactive. They are unidirectional in nature (from sender to recipient), rather than bidirectional

(dialogue between at least two individuals) (Wirth, 2014). Climate change and adaptation training-courses, which are generally aimed at capacity-building, are one of the climate change communication strategies that sometimes use a combination of different modes of communication and are more interactive in nature (Wirth, 2014). Climate training-courses take place in both the developing and developed world; however, there has been little systematic evaluation pertaining to these training-courses.

2.7 The importance of application and transfer of knowledge for capacity building

Training-courses are often run and funded with the expected outcome being an increased capacity to deal with the impacts of a changing climate (CSAG, 2016). However, the assumption that if individuals know more about climate change, they will make more informed decisions persists in the scientific community (Kellstedt et al. 2008). This assumption is based on the belief that attending training-courses will increase an individual's knowledge of climate change and adaptation, and this knowledge will transfer to the individual's workplace – allowing them to make better informed decisions. This assumption is referred to as the Knowledge Deficit Model, and is explored in more detail below.

2.8 The Knowledge Deficit Model (KDM)

The KDM argues that an increase in knowledge directly affects behaviour. It argues that filling cognitive gaps creates a heightened awareness of the issue, and provides cues for appropriate ameliorative actions (O'Connor, et al. 1999). Kellstedt, et al. (2008) argue that the KDM does exactly the opposite of what is assumed. The authors argue that the more information a person has about climate change, the less responsible they feel about it (Kellstedt, et al. 2008). On the other hand, Sturgis and Allum (2004) argue that the KDM is supported by cross-national empirical evidence, with a robust correlation between knowledge and favourable attitudes towards science in general, and quote a number of studies involving public opinion and science, including those by Bauer et al., (1994); Gaskell et al., (2001); Sturgis and Allum (2000); and Sturgis and Allum (2001). However robust the evidence, positive correlation is not particularly strong (Sturgis and Allum, 2004).

Since the relationship between knowledge and subsequent behavioural change continues to be up for debate, it may be opportune to take a step back and explore other behavioural theories that include the concept of knowledge in behavioural change, but in more indirect ways. Two such theories include the theory of reasoned action and the theory of planned behaviour. By exploring these two theories, I look at the relationship between knowledge and perceptions and attitude change, since these relationships are well established in the behavioural psychology literature and may provide clues into the role of climate change communication efforts and behavioural change (Breckler and Wiggins, 1989).

Furthermore, research from the field of adult training have revealed that only about 10 -15 percent of employee training results in transfer to the workplace (Cromwell and Kolb, 2004). A study by Wexley and Latham (2002) found that approximately 40% of all participants continued to effectively apply the knowledge, skills, and attitudes gained in training to their jobs immediately after the training took place. However, this number drops to 25% after 6 months following the training, and 15% after 1 year.

2.9 Knowledge and Behaviour Change

Although individuals are rational actors who process communicated information in different ways, the reasons for particular behaviour are influenced by beliefs that may or may not be rational, logical, or correct, by an objective standard (Fishbein and Azjen, 2010). This reality is a fundamental assumption of both the Theory of Reasoned Action and Theory of Planned Behaviour.

The central assumption of The Theory of Reasoned Action (TRA) (**Figure 2.3**) is that behavioural intent is the most direct determinant of behaviour. The TRA further hypothesises that behavioural intent is a function of attitude (towards performing the behaviour), and one's subjective norms (that are associated with the behaviour) (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). However, TRA only works if the individual has a large degree of control over their behaviour in the situation, i.e. volitional control. When

circumstances are such that volitional control is low, one might need to consider the Theory of Planned Behaviour (TPB) (Figure 2) (Glanz, et al. 2015).

The TPB is only different to the TRA in that it has the additional element of perceived control (Figure 2). The TPB therefore takes into account situations where one might not have complete voluntary control over one’s own behaviour (Glanz, et al. 2015). Azjen’s (1985) inclusion of perceived control (shaded orange boxes in **Figure 2**) is partly based on the idea that behaviour is jointly determined by motivation (intention) and ability (behaviour control).

The intention is controlled by the individual’s attitude, subjective norms, and the individual has perceived behavioural control (i.e. a person’s perception of their ability or feelings of self-efficacy to perform behaviour) (Azjen, 1991).

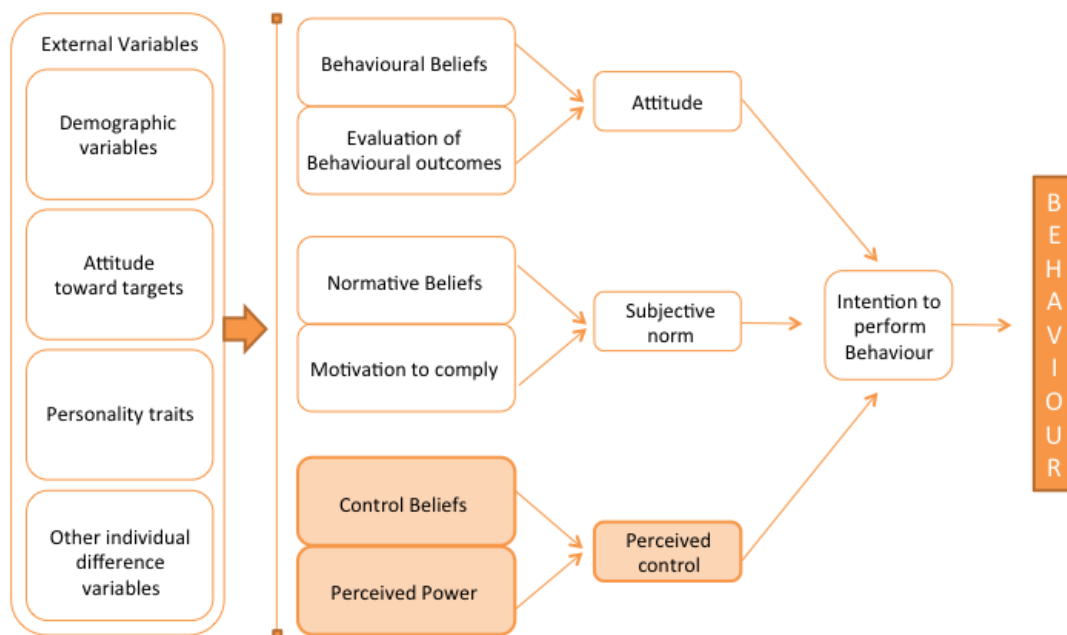


Figure 2: Theory of Reasoned Action and Theory of Planned Behaviour. The unshaded boxes show the TRA, the entire figure shows the TPB (extracted from Glanz, et al. 2015).

Intention has been shown to be the most important variable in predicting behaviour, which suggests that behaviours are often strongly linked with one’s personal motivations (Godin and Kok, 1995). For perceived behavioural control to influence behaviour change, it is

important that a person is able to perceive that they have the ability to perform the behaviour (Grizzell, 2007).

Although the TPB is similar to the TRA, it does work better for situations where the individual has low volitional control, because of the added element of perceived control. This accounts for factors outside the individuals control which might affect his or her intentions and behaviours. An individual's perceived control is determined by control beliefs, which is the presence or absence of barriers to behavioural performance. The control beliefs are weighted by their perceived power (i.e. the impact of each control factor to enhance or hinder the behaviour) (Glanz, et al. 2015). The literature on behavioural theory suggests that, if an individual is motivated to make behavioural changes, and believes that they capable of such actions, they are likely to make those changes. If I apply this theory to the realm of climate change communication; if an individual attends a climate change training course, there is the potential that just being engaged with, and informed that they are able to make a difference (i.e. increase perceived control), could result in behaviour change.

2.10 Behaviour, perceptions and attitudes

Perception can be defined as the process of interpreting messages from one's senses; the process of extracting meaning and installing order in one's environment (Bowditch et al., 2008). The significance of this definition is in the word interpreting, since different people can have different interpretations of the same events. Since experiential learning (see section 2.6) involves learning from past experiences and events, it is important to note that different people will perceive the same event in different ways, and can subsequently learn different things from it (Segall, et al., 1966; Bowditch et al., 2008).

One of the foremost determinants of how and why people begin and continue with certain behaviours is grounded on the ideas of **sensation** and **perception** (Bowditch et al., 2008). Sensation concerns the physical stimulus of the senses, that is, one's ability to touch, taste, see, smell, and hear (Bowditch et al., 2008). Bowditch, et al. (2008) provide an eloquent

definition of perception: Since different people can view the same situation in disparate ways, the interpretation of the meaning of a particular event determines how these individuals will react to it. Thus, perception can be thought of as an intervening variable that influences behaviour (Bowditch et al., 2008).

The relationship between perceptions and attitudes is complex, but they are very closely related. Put simply, perceptions play a role in how attitudes are formed. Campbell (1963); Allport (1954); Bowditch et al., (2008), and others report that attitudes might be learned through the following processes:

1. One's perceptual inclinations and biases;
2. One's perception of other people's responses to a certain situation;
3. One's perception of the outcomes of another person's experiences;
4. The outcomes of one's own experiences; and
5. Instruction about appropriate responses to a particular stimulus.

Depending on which field of research one explores, the word attitude has variable meanings (Dillard, 1993). In social science research there are varying conceptualizations of attitudes, however, most of them are linked to cognitive, emotional, and behavioural processes (Breckler and Wiggins, 1989; Bowditch, Buono, and Stewart, 2008). Attitudes can be defined as a predisposition to respond to a stimulus in a positive or negative way. The stimulus could be anything from an event, to a thing, a place, a particular issue, or even a person (Fishbein and Ajzen, 1975; Pinder, 1984; and Crites et al., 1994).

Another definition given by Hogg and Vaughan (2005, p. 150) describes an attitude as:

"...A predisposition or a tendency to respond positively or negatively towards a certain idea, object, person, or situation. An attitude is a relatively enduring organization of beliefs, feelings, and behavioural tendencies towards socially significant objects, groups, events or symbols."

An attitude is described as having three components: cognitive, affective, and behavioural. The cognitive component includes one's beliefs and knowledge about the stimulus, the affective component refers to one's feelings, and the behavioural component is one's

inclinations to behave in certain ways as a response to one's feelings and cognitions (Bowditch, Buono, and Stewart, 2008).

Generally speaking, one's attitude influences one's inclination to act in a particular way (Cooper and Croyle, 1984; Miner, 1988; Kidwell and Robie, 2003). However, whether a specific attitude produces particular behaviour depends on a combination of factors. Therefore attitude is only one of many influential factors that may affect an individual's behaviour (Bowditch, Buono, and Stewart, 2008).

Although many studies have examined the relationship between knowledge and attitudes in relation to science (e.g. Bauer et al., 1994; Grimston, 1994; McBeth and Oakes, 1996; Miller et al., 1997; Sturgis and Allum, 2000, 2001), the results of these studies are quite diverse, and even contradictory at times (Evans and Durant, 1995). Allum et al. (2008) reviewed evidence on the relationship between public attitudes and public knowledge about science across 40 countries to data from 193 nationally representative surveys carried out since 1989. Allum et al. (2008) only found a small positive correlation between general attitudes towards science and general knowledge of scientific facts (Allum et al. 2008). The implications for climate change and adaptation training is that more knowledge of the topic does not necessarily correlate with more positive attitudes towards climate change and adaptation. Nonetheless, capacity building training-courses persist in the world of climate change communication, and in order to maximise the effect of these training-courses to potentially influence knowledge, perceptions and/or attitudes – it is worth exploring how best to communicate complex and complicated climate change information.

2.11 Practical methods for effective communication and training

Wirth and Grothmann (2014) developed a set of factors, which they argue are good examples of how to communicate climate change information. Some of these factors include: the “translation” of the meaning of climate change, such that it can be understood in the context of everyday life; the use of examples; the use of trusted messengers and opinion leaders; the use of methods which attract and keep the audience's attention (e.g. stories, games and other innovative teaching methods); and the use of pictures and

visualisations (Wirth and Grothmann, 2014). Similarly, the Red Cross / Red Crescent Climate Centre (RCRCCC) has also recognised enormous potential in using games to engage with users and a variety of stakeholders (Climate Centre, 2016). Over the past 10 years the RCRCCC has developed a range of tools and educational games in order to help society make climate-smart decisions and thereby reduce the risks of a changing climate (Climate Centre, 2016). The RCRCCC believe that climate change communication material is most effective if it is interactive, flexible, and contains a mix of exercises, games, video clips, presentations, reading materials, and case studies (Climate Centre, 2016).

Whitton and Moseley (2012) argue that working collaboratively can allow learners to practice their strengths whilst learning from others who are stronger in other areas. This can help learners strengthen critical thinking and analytical skills, and think creatively about problem solving. Collaborative group work also forces individuals to rationalize and validate their ideas, whilst learning about other's perspectives and interpretations (Whitton and Moseley, 2012). This kind of active learning is often contrasted to traditional lectures, where learners passively receive information from a lecturer.

One of the key benefits of using training-courses for the communication of climate change information is the opportunity to design them such that they are bidirectional in nature. Studies which looked at classroom communication, for example those by Dawes et al. (2000) and Alexander (2004), indicate that particular patterns of exploratory talk, dialogue, and even argumentation promote deeper cognitive thought. Through these communication mechanisms, teachers and learners are both key participants in knowledge construction (Wolfe and Alexander, 2008).

Nerlich et al. (2010) support the concept of bidirectional communication and suggest a mix of communication methods and strategies be used to communicate climate change issues; ranging from verbal to visual, from the spoken word to digital messages. Given that climate change training-courses can be unidirectional or bidirectional depending on how they are designed, there is an opportunity to improve in this arena such that they become more interactive and more bidirectional (dialogical).

Games are a good way to increase interaction in training efforts. Games can enable learners to partake in active experience, and not simply passively receive information (Whitton and Moseley, 2012). Games allow learners to explore, try things out, and see the effect of their actions (Whitton and Moseley, 2012). The Experiential Learning Cycle, developed by Kolb (1984), puts forward the idea that students learn better by discovering and engaging in experiences for themselves, and eliciting their own meanings and understandings from these experiences. This process puts experience at the heart of learning (Whitton and Moseley, 2012).

A key point to remember when using games in adult training-courses is the need for a clear explanation of the games. This is because too many games can make participants feel like the course has been de-valued (Whitton and Moseley, 2012). Therefore, to have a positive effect on learning, there needs to be an appreciation of the purpose and value of the game, and intrinsic interest in the game subject matter for it to work (Whitton and Moseley, 2012).

2.12 Theoretical framework and conceptual approach

The theoretical framework used to provide context and define relationships in this thesis draws on a range of disciplines, identifying and applying relevant theory at different stages to explore the research objectives through a multidisciplinary lens (Figure 3). The research conducted can be categorised as belonging to the field of climate change and adaptation, under the sub-category of building adaptive capacity. Communication and training efforts are sometimes used to build adaptive capacity. These bodies of literature are illustrated in Figure 3. Since this research focuses on two training-courses, it is situated within the broader literature of communication and training. However, in order to strengthen the theoretical framework and apply the most well established body of literature available, the communication and training theory draws on the broader field of education, rather than climate change capacity building. This encourages a multidisciplinary approach. In order to assess the effectiveness of different teaching and training methods, concepts from the field of education relating to how people learn, such as cognitive processing systems, as well as analytic and experiential learning are adopted. Lastly, in order to establish how knowledge,

perceptions, and attitudes relate to each other, theory and concepts from the field of behavioural psychology are referred to.

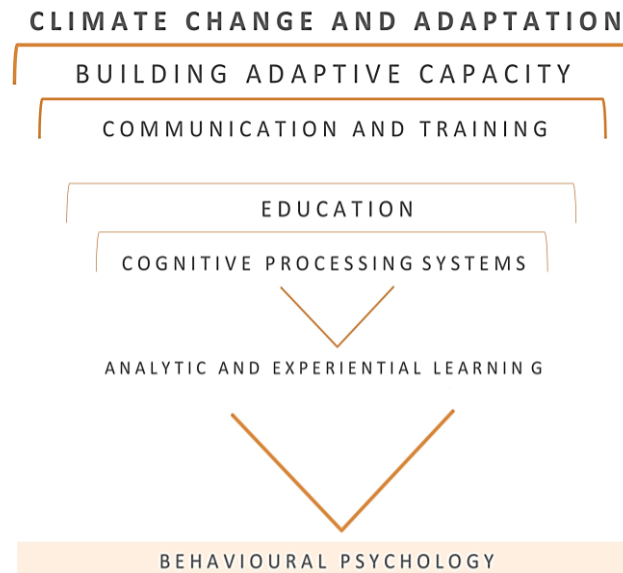


Figure 3: The broader bodies of literature referred to in order to in this thesis, in order to approach the research question through a multidisciplinary lens.

With the theoretical framework described above in mind, this thesis focuses around the experiences of 37 professionals (each of whom are represented by the orange person in Figure 4) who attended one of the two-climate change and adaptation training-courses observed during the data collection. This thesis describes the changes that took place, in terms of participant knowledge and perceptions of, and attitudes towards climate change and adaptation issues. This thesis explores the experiences of the participants, by assessing whether or not attending a training-course influences how participants answer questions relating to climate change and adaptation. The questions were designed to measure participant knowledge and perceptions of, and attitude towards climate change and adaptation. This thesis also aims to highlight methods of teaching and elements of course design which participants themselves recognized as enablers to their understanding, which is the process of moving from A to B₁ or A to B₂ in Figure 4.

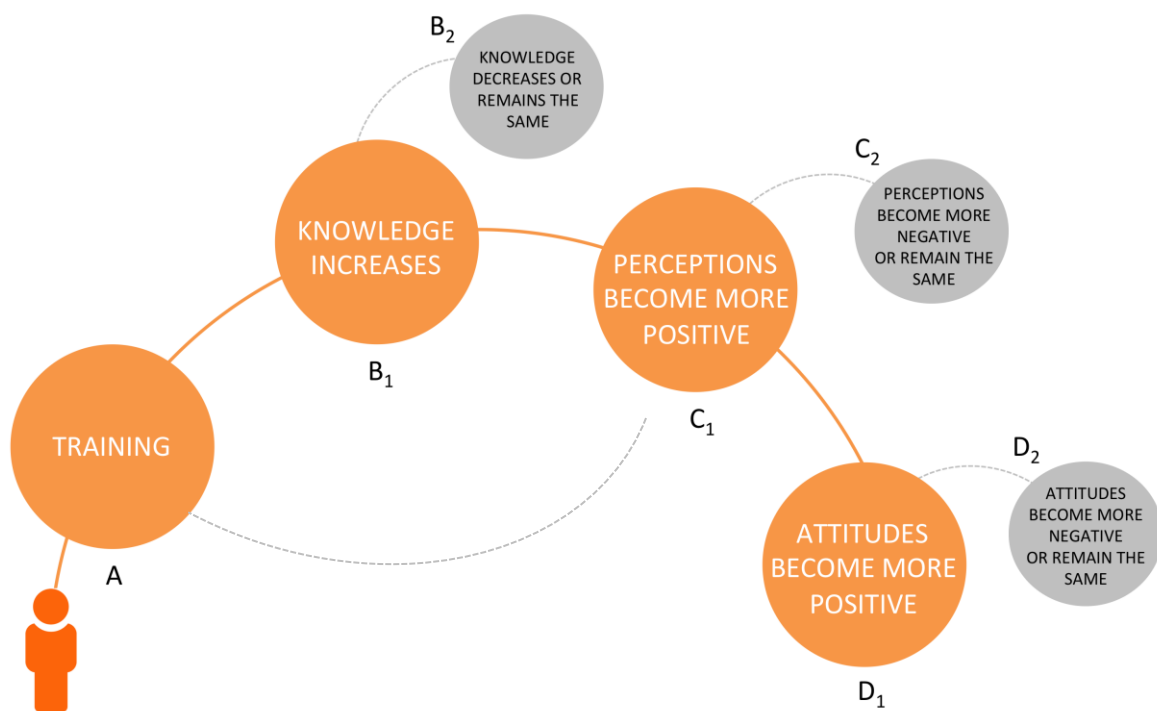


Figure 4: The training experience and the potential it has to effect knowledge, perceptions, and attitude. The orange person illustrated in this figure represents each of the 37 participants, as they process the training-course experience.

When a participant attends a training-course (A), the result of attending the training-course is either an increase (B₁), decrease or neutral (B₂) response in participant knowledge. Either as a result of a knowledge change, or simply as a result of the experience of attending a training-course. The grey dotted lines that lead to grey circles represent the different potential pathways that might occur throughout the process, whilst the solid orange lines and circles represent the process of change.

2.13 Conclusion

This literature review provided an overview of concepts and theories which relate to the conceptual and theoretical approach of this study. The first section focused on climate change communication, revealing a field of literature which is growing and changing as the science which underpins the climate change is more broadly agreed upon by scientists, and

more widely accepted by the public, politicians, and mass media. It then explored climate change communication strategies, and discussed how different modes of communication can trigger different processing systems in the brain – which in turn affect how information is remembered and used. The final section provided an explanation of the theoretical framework and conceptual approach adopted.

3. Methodology

This section begins with an introduction, and describes the methods of data collection, data processing and analysis used to obtain the results presented in chapter 4. The chapter begins by describing the climate change training-courses used as case studies for this research. Following this, the participants of training-courses are described, and definitions of training methods are provided. The pre-and-post tests, semi-structured interviews, feedback slips, and analysis procedure is then described. Finally, the limitations of the research are outlined.

Introduction

The impact of the training course on participant knowledge of, as well as perceptions and attitudes towards climate change and related issues were assessed through the use of quantitative measures. Qualitative measures were used to verify participants' perceptions of their experiences relating to the effectiveness of different training methods. The qualitative methods allowed for the exploration of how people were thinking about the training-courses more holistically.

The research was quasi-experimental in nature. Quasi-experiments seek to evaluate the impact of some factor (such as a training-course) on participants, and aim to test hypotheses that are grounded in prior research (Huysamen, 2001). Although this sounds similar to an experimental design, quasi-experiments lack random assignment of groups. Since the participants of the climate change training-courses are an opportunistic sample, rather than a random selection of individuals, the research method is considered a quasi-experimental design. The quantitative method of data collection used was a Pre-test / Post-test, although certain questions in the test were qualitative in nature. The Pre-test / Post-test data was used to address the first three objectives of the research agenda. The qualitative data collection methods used were semi-structured interviews, and feedback slips. The qualitative data collection was used to address the fourth research objective.

3.1 Data Collection

Data collection techniques included a combination of qualitative and quantitative data collection techniques: pre and post training tests (in the form of questionnaires), semi-structured interviews, anonymous feedback slips and observation.

3.1.1 Training-courses

The Climate System Analysis Group (CSAG) is based at the University of Cape Town, South Africa, and is a multi-disciplinary research group. CSAG blends research in atmospheric science, climate modelling, and applied climate analysis with multidisciplinary elements of vulnerability, impacts and adaptation science. CSAG regularly convene training-courses, which aim to teach professionals, mostly from African countries, about the science of climate change, vulnerability and adaptation. These training-courses incorporate a number of different tools and methods of teaching to convey the often-complex messages of climate change (CSAG, 2016). This research project studied the participants and looked at the training dynamics of two such training-courses run by CSAG.

The training-courses used as case studies for this research were developed and run by the CSAG. The first training-course took place in July 2015, and is an annual event run by CSAG. The second course took place in August 2015 and was an activity designed for the African Climate Development Initiative's (ACDI) ASSAR (Adaptation at Scale in Semi-Arid Regions) project. The ACDI is a university-wide initiative at the University of Cape Town, which aims to support collaborative research and training in climate change and development. ASSAR is one of ACDI's projects which aims to use insights from multiple-scale, interdisciplinary work across seven semi-arid countries (including India and countries in East, West, and Southern Africa) in order to improve the understanding of the barriers, enablers and limits to effective, sustained and widespread adaptation out to the 2030s. The first training-course had a programme of five full days, the second training-course had a slightly longer programme of eight days (each training-course programme is available in Appendix A). The first training-course had 17 participants, and the second training-course had 20 participants. The first training-course consisted of 27 sessions of training over the course duration; the second training-course consisted of 33 sessions of training. The methodology described in

this chapter was applied in the same way at both training-courses. Since the training-courses were very similar in terms of design and content, the results were pooled to create a total sample size of 37 participants.

The research group, which designs and runs the climate change training-course, tries to incorporate a number of different methods of teaching into the programme, to keep participants interested and to allow participants the opportunity to learn in different ways. The training-courses incorporate a mix of games, group-work, and bidirectional (two-way) teaching techniques, along with traditional PowerPoint lectures and methods of teaching. The definitions outlined in Table 2 apply to the communication and training methods referred to throughout this thesis.

Table 2: Definitions of communication and training methods.

Method	Definition	Reference
PowerPoint™ lectures	A PowerPoint™ presentation is a presentation created using Microsoft PowerPoint™ software. The presentation is a collection of individual slides that contain information on a topic.	Krizo, 2016.
Videos	The recording, reproducing, or broadcasting of moving visual images.	Merriam-Webster, 2016.
Exercises	A task set to practise or test a skill.	Merriam-Webster, 2016.
Role-playing	Role-playing is usually unrehearsed and unprepared problem solving in which certain members of a group assume specified roles in a context that is non-threatening. Role-playing provides students with a chance to act out, rather than merely talk about, ways to solve problems effectively.	Weber, 2006
Games	Games can take many forms, but in the classroom, any activity that involves a competition, social interaction, and some form of prize or award would be considered a game. Classroom game activities are typically not graded, and student participation is based on the desire to contribute to a team or to individually achieve some prize or recognition. Usually games have ‘winners.’ Ideally, even the ‘losers’ of the game should feel that the experience was enjoyable.	Weber, 2006
Case studies	A particular instance of something used or analysed in order to illustrate a thesis or principle.	Merriam-Webster, 2016.
Group work	Group work involves students working collaboratively on set tasks, in or out of the classroom.	Sydney, 2016.

3.1.2 Participants

The training-course participants were mid-career professionals. Mid-career professionals are individuals who are well established in their careers, and have been working for around five to ten years. Participants came from 15 different countries. Of the 37 participants, 9 were from South Africa, 4 were from Botswana, 4 from Ghana, 4 from India, 2 from Zimbabwe, 2 from Mali, 2 from Namibia, and 2 from Ethiopia. There was 1 participant from Lesotho, 1 from Swaziland, 1 from Tanzania, 1 from Angola, 1 from Nigeria, 1 from Mozambique, 1 from Kenya, and 1 from the United Kingdom (Figure 5).

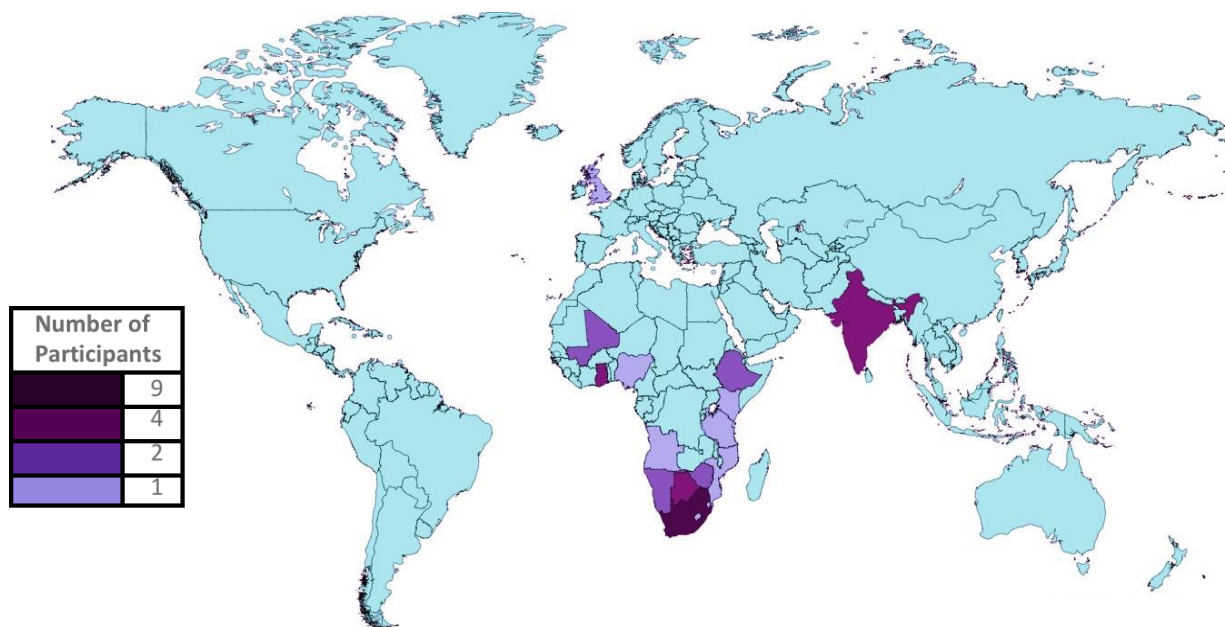


Figure 5: The geographic areas from which the 37 participants originated.

The participants also came from a range of different backgrounds. As can be seen in Figure 6, most of the participants worked in the government sector. Others worked for Universities, NGOs, research organisations and NPOs.

The two training-courses studied were chosen primarily because they historically attracted participants who work in government. Government employees were of interest since they are often decision-makers and planners that need specific types of information to do their job, and make informed decisions. They need to know information about the social,

economic, and environmental conditions of the areas they are in charge of because the decisions they make have the potential to enhance and protect communities from adverse social and environmental impacts.

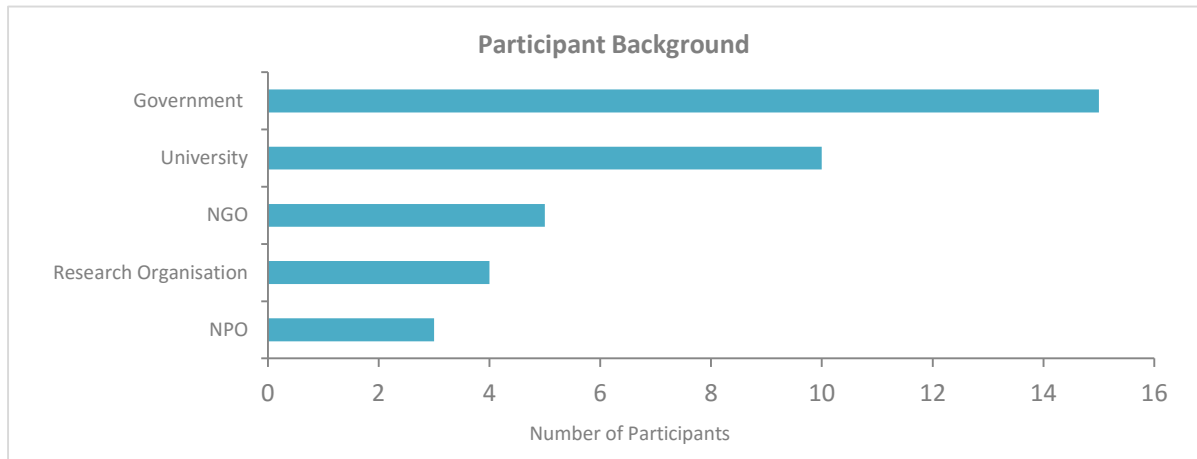


Figure 6: The area of occupation of the participants.

Tribbia and Moser (2008) argue that coastal managers will be better able to handle and deal with the challenges and impacts of a changing climate if they begin preparing for the changes early on. This thesis follows this line of thought, in that the same argument applies for any government employee who is involved in decision-making and future planning. It is therefore critical that relevant climate information be transferred and uptake improved, such that those who need to use the information or make better informed decisions might be able to get ahead of the emerging and worsening problems (Tribbia and Moser, 2008).

We need the information that scientists produce to percolate to the relevant decision-makers and planners such that local, municipal, and national government have the information they need to make informed decisions and can begin to mitigate and adapt to the impacts of climate change (Tribbia and Moser, 2008). As it stands, many management decisions continue to be made without the relevant scientific input (Sarewitz and Pielke, 2007). Dabelko (2005) argues that the “non-familiar, technical jargon common in many scientific reports can form tremendous hurdles for non-experts to overcome”. This hurdle might be a reason for the disconnect that remains at the intersection between science and decision-making.

3.1.3 Pre-test / post-test

The pre/post-test method was used to determine whether or not attending a climate change training-course improved knowledge of climate change and related issues. These tests were also used to explore the different effects the training-course had on participant perceptions of, and attitudes towards, climate change, adaptation and related issues. This data was also used to assess whether a statistical relationship existed between knowledge of climate change, and perceptions and attitudes towards climate change.

The pre-and-post training perceptions and attitude responses were scaled on a Likert scale in order to numerically measure changes in responses. The Likert scale was structured such that higher scores correspond to more positive perceptions and attitudes, whilst lower scores correspond to more negative perceptions of and attitudes towards climate change. A description of the positive and negative perceptions and attitudes scale developed for this research is available in Appendix B.

Important to note is that changes in perceptions and attitudes were considered more or less positive as defined by the Likert Scale (Appendix B). Perceptions and attitudes were considered more positive if a participant answered the question in such a way that suggested willingness to engage with the topic of CCA and related issues, and willingness to support the CCA agenda.

The pre-test/post-test design (also known as before-and-after) takes a set of measurements (these are called base-line measures) from a set of respondents, who are then subjected to an experimental variable (in this case a climate change training-course), and afterwards measured again. The difference between post-test and pre-test results or observations is said to be the 'effect' of the experimental variable. Each individual who participates in the quasi-experiment has a change score calculated in terms of their knowledge, perceptions and attitudes (Huysamen, 2001). The pre-test/post-test design is a very popular quasi-experimental data collection tool (Huysamen, 2001). Similar pre/post-test studies have been conducted by Lowe et al. (2006), in which the authors investigated climate change

engagement with the film “The Day After Tomorrow” and also by Henriksen and Jorde (2000) where the authors investigated cognitive change.

The first questionnaire (pre-training) assessed participants’ baseline knowledge, perceptions and attitudes towards climate change and related issues. The second questionnaire (post-training) had the same content as the first questionnaire, and was used to identify whether the participants experienced any changes in their knowledge, perceptions and attitudes towards climate change and related issues. The pre-and-post training questionnaire was split into two sections, a set of questions testing knowledge, and another section with questions, which gauged perceptions and attitude (the questionnaires are available in Appendices B and C). These two sections were analysed separately.

The knowledge change was assessed by comparing the number of correct answers achieved in the pre-test to the correct answers in the post-test. There were limited time slots during the training-course for participants to partake in this research. Therefore, the questionnaire could only have a limited number of questions. The knowledge test consisted of 13 questions including questions relating to climate models, adaptation and mitigation, as well as basic climate change related definitions. The CSAG course convenors were given the opportunity to review and comment on the questions that were developed, and ensured that the topics referred to in the questions would be covered in the course content. Any improvement in the number of correct answers to these 13 questions was considered an increase in knowledge, and any decrease in correct answers to these 13 questions was considered a decrease in knowledge. Changes in perceptions and attitudes were measured using a Likert/Summated scale. Each individual’s perception and attitude score (measured on a Likert scale) was recorded in the pre-test as well as in the post-test. In order to assess whether each participant experienced a change in the way in which they answered the perceptions and attitudes section of the test, each individual’s pre-score was compared with the score they achieved in their post-test. In order to assess the overall effect of the training-course on participant perceptions and attitudes, the participant scores were averaged.

3.1.4 Semi-structured interviews

The semi-structured interviews were structured to tease out methods of communication and training that are most effective in enabling participants to understand climate change and related issues. The interviews took place once the training-courses were completed. The semi-structured interviews were conducted in order to ascertain which specific training-course communication and teaching methods participants felt were the most effective in enabling their understanding of the course content. Before each interview was conducted, the interviewee was provided with a brief explanation of what the purpose of the interview was. The terms of the interview were then discussed, and participants were asked whether or not they were comfortable being recorded. The topics discussed during the interviews were the lecturers, course content, methods of communicating the content, and participants and colleagues. The following five questions were posed to each interviewee:

- How did the lecturers at the training-course affect your training-course experience?
- How did you find the course content in terms of pitch?
- What do you think of the different methods in which the course content was communicated and taught?
- Was there anything specific about the training-course, which made it easier or more difficult for you to engage with the course content?
- How did the other participants affect your workshop experience?

There was significant time constraint in terms of the availability of participants to be interviewed. Therefore interviews took place both during the last two days of training (once all methods of teaching had been used), and in the week after the course. Since many of the participants do not live in Cape Town, some interviews took place over Skype. The interviews were conducted, recorded, and transcribed. All 37 participants were asked for interviews, 14 volunteered and were able to make themselves available to answer the semi-structured interview questions. The five questions were used to guide conversation in the interviews, but not all interviewees answered all the questions. Therefore, when analysing the interview data, it was not possible to allocate precisely how many participants, for example, preferred one training method over another. The interview data were analysed for

dominant themes, rather than frequency counts. Once the interviews were transcribed, a manual coding method of content analysis was used to identify and tease out themes from the data. The participants remain anonymous throughout this thesis, all references to interviewee quotations can be found in the references under van Wyk, 2015.

3.1.5 Feedback slips

There were three occasions per training-course for the participants to place feedback slips into a box, anonymously. The feedback on the feedback slips was reviewed before the interviews took place, and provided clues to themes that could be explored during the interviews. The feedback slips were colour coded, red paper slips with a frowning face were for “Dislikes” and green paper slips with a smiling face was for “Likes”. The feedback from all of the slips was transcribed and organised by the frequency in which the topic was mentioned. Not all participants submitted feedback slips, since the process was voluntary.

3.2 Procedure

On the first day of each of the training-courses, participants (17 in the first training-course and 20 in the second training-course) agreed to partake in this study. After the Informed Consent forms were collected, the participants were asked to take the first pre-test. The Post-test was delivered on the last day of each training-course, during the final session of the programme.

The pre-and-post training were setup using Survey Monkey, an online questionnaire builder. The participants each had a computer in front of them (Figure 7), and on the desktop of the computer a shortcut to the online survey was provided. The test was delivered in this way to make the pre-and-post-test process as seamless as possible, and allowed participants to answer the questions with ease, as no writing was required. The use of digital tests also meant that there was no manual data capturing, which saved time and minimised the possibility of data capturing mistakes.

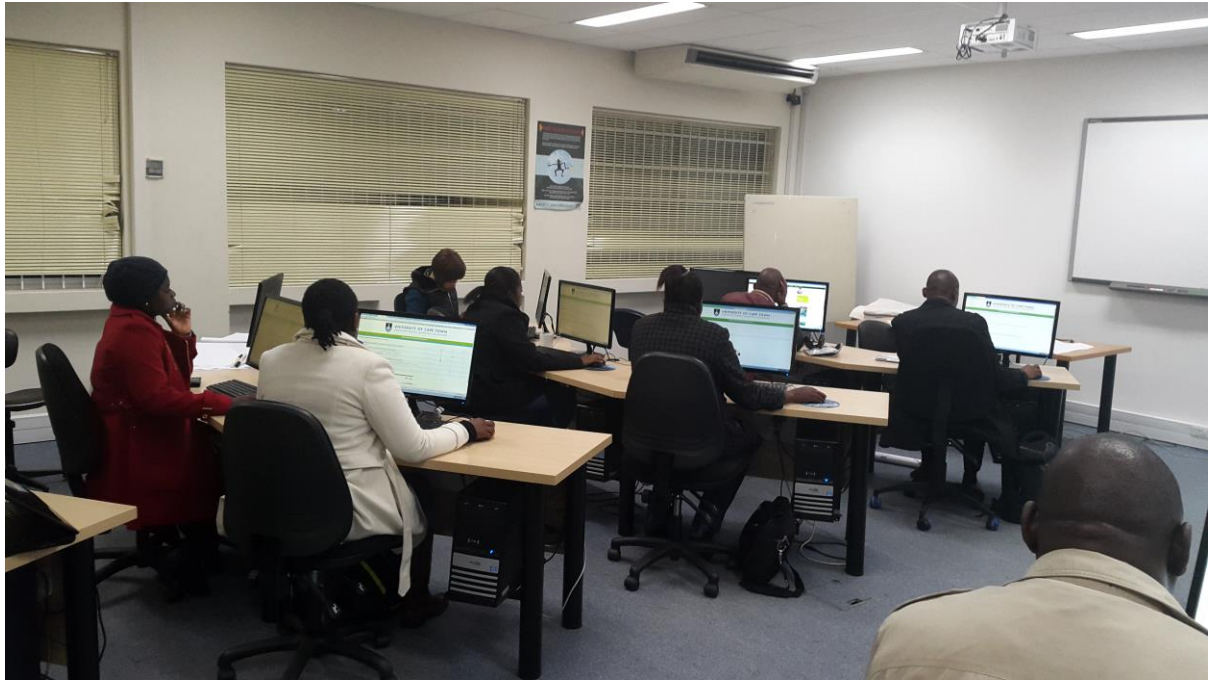


Figure 7: Participants seated in front of their computers, completing the online questionnaire before the training-course commences.

The data collected using the pre-and-post training-course questionnaires was analysed in Microsoft Excel, with the help of a statistical software add-on. Pivot tables were used to create the graphs presented in the Results and Analysis Chapter.

Two statistical tests were conducted on the pre-and-post questionnaire data. The paired sample t-test was used to compare the population means in the case of two samples (Knowledge pre-and-post results, and Perception and Attitude pre-and-post results respectively). Paired sample t-tests are a statistical technique often used in 'before-after' studies (Statistics Solutions, 2016). The paired sample t-test technique was used to determine if the changes observed in the knowledge, perceptions and attitude tests were of statistical significance. The second statistical technique used was Pearson's correlation coefficient. Pearson's correlation coefficient is used to measure the strength of a linear association between two variables, that is – if two variables correlate (Statistics Solutions, 2016). Pearson's correlation coefficient was used to determine whether knowledge, and perceptions and attitude scores in this study were correlated. The correlation coefficient was calculated for the pre-test scores, as well as for the post-test scores. These two

statistical techniques were chosen because they were appropriate for the size of the sample (n=37), as well as the distribution of the sample (normal).

3.3 Limitations

The methodology and results presented in the next chapter (Results and Analysis) are subject to a number of limitations, outlined below.

3.3.1 Sample size

Perhaps the greatest limitation of this research was the small experimental sample size. The two training-courses had 17 and 20 participants in attendance, respectively. In order to improve the size of the sample for analysis, the questionnaire responses from the training-courses were pooled together to create a total sample size of 37 participants. The semi-structured interview responses were also pooled, with 8 of the interviewees having attended the first training-course, and 6 interviewees having attended the second training-course. The statistical and theoretical generalisability of this study therefore has its limitations.

3.3.2 Pooling data from two training-courses

Since the training-courses were opportunistic samples, and the number of participants who attended each course was not controlled for, it was necessary to pool the data from the two training-courses. The pooling of participants (20 from the first training-course plus 17 from the second) into one sample of 37 presents a limitation, since the two training-courses took place at different times with different sets of participants, and a few varied lectures. However, the two courses were designed and run by the same research group (CSAG), and mostly the same lecturers were employed to teach the sessions.

3.3.3 Self-selected sample

Participants who attended the training-courses were self-selected. The possibility that an individual participant chose to attend a climate change training-course could be based on

specific reasons such as personal interest, personal history, or prior experience. This was therefore taken into consideration when the results of the observed changes in knowledge, perceptions and attitudes, as well as methods of teaching and communication were considered.

3.3.4 Measuring change

The pre/post-test method of measurement assumes that any change observed in the Post-test is a direct result of the intervention that is being tested, i.e. the training-course. However, participants may have encountered other experiences during the time period in which they were enrolled in the course, which could have affected the way in which they responded in their post-test. Another limitation with measuring knowledge changes was the assumption that the knowledge test measured a broad enough scope of what participants learnt. It is entirely possible that some participants learnt new things, but the knowledge questions in the pre and post tests were not broad or sensitive enough to measure this gain in knowledge.

In terms of using pre/post tests to measure changes in knowledge, Dimitrov and Rumrill (2003) have noted that the relationship between raw scores and a participant's ability score is not linear. This means that the knowledge scores obtained, in both the pre-test and the post test, may not be an accurate representation of participant's actual knowledge.

Furthermore, in the case of both the knowledge test, and the perception and attitude questionnaire, participants may have answered untruthfully, or without engaging properly with the content. The questionnaire was intentionally designed such that it would not take long for participants to complete. This meant that only a few aspects of the training-course were tested in the knowledge test, and since the participants had received the same test in the pre-test they might have guessed that they would be receiving the same post-test after the training-course took place, and specifically focused on those questions during the course. The number of knowledge questions (13) meant that the amount of data collected was limited. It was therefore decided that it was more important that participants be allowed

enough time to complete a few questions and therefore have a set of high quality data, rather than an abundance of data that was produced in a rushed and uncommitted fashion.

The Likert/Summation scale was used to measure changes in perceptions and attitude, and although it is a popular method of measuring perception and attitude change, it is not without its limitations. For one, the perceptions and attitude questions may not have been sensitive enough to capture actual changes in participant perceptions and attitudes. Also, it is possible that since participants were attending a climate change training-course, that they answered the perception and attitude questions in a way in which they believed was the “acceptable” responses given what they already knew about the training-course, the institution at which it was hosted, and the organisers themselves. A further limitation in using the Likert scale was the subjectivity in the question of what is considered positive or negative change in perceptions and attitudes.

For future studies, it is recommended that the researcher introduce an additional baseline knowledge, perceptions, and attitude test that participants complete before arriving at the training-course. This will allow the researcher to adjust the pre/post questions to be sensitive to the actual participant’s level of understanding and general perceptions and attitudes. This study used a pilot of 10 tertiary-level educated individuals to test the difficulty of the questions.

4. Quantitative Results and Analysis

This chapter presents results and provides analysis of the quantitative data collected using pre-and-post training questionnaires. The chapter is divided into four sections. The first section looks at participant responses to statements regarding the way in which they engage with climate change and related issues in their workplaces. The second section addresses the question of participant knowledge of climate change and related issues as identified in a pre and post survey before and after the training. The third section looks at participant perceptions of and attitude towards climate change and related issues, and includes analysis on participant perceptions of and attitudes towards addressing and prioritising climate change in the workplace, and the role of government in addressing climate change issues. The fourth section explores the possible relationships between knowledge, perceptions and attitude.

4.1 Participants, Climate Change, and the Workplace

In order to gauge how pressured and responsible participants who attended the training-course were already feeling, in terms of engaging with and including climate change and related issues in their everyday workplace activities, the pre-test survey included three questions relating to responsibility, expectations and pressure. These questions were posed in order to understand how participants engaged with climate change in their workplaces, before attending the training-course.

The first question attempted to gauge participant's sense of responsibility in terms of highlighting and/or addressing climate change related issues in the workplace (Figure 8). Of the 37 participants, 34 felt a very strong sense of responsibility to highlight and/or address issues relating to climate change in their workplace (92%).

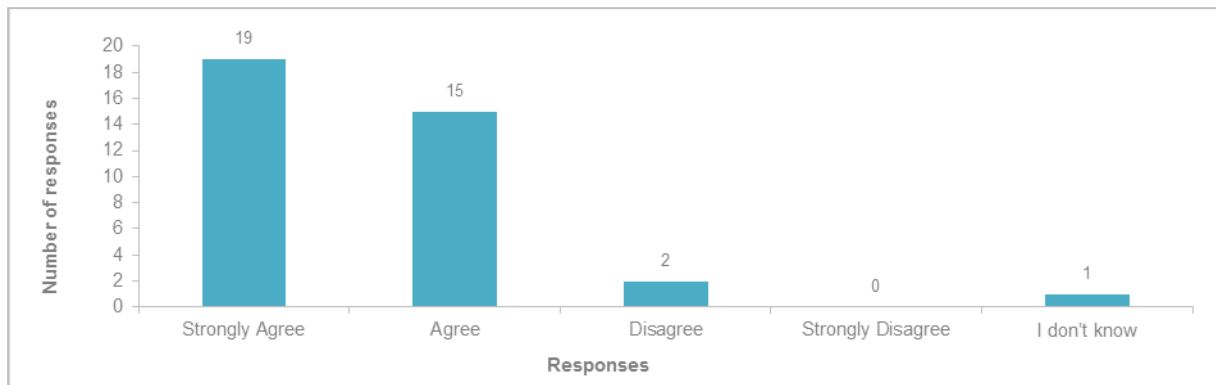


Figure 8: Participant responses to the statement “I feel a very strong sense of responsibility to highlight and/or address issues that relate to climate change in my workplace’.

The second question gauged whether or not it was already expected that participants apply knowledge of climate change when making decisions at work. Responses show (Figure 9) that the majority (84%, n=37) of participants were in positions where it is expected that they apply knowledge of climate change when making decisions in their workplaces. This is both interesting and somewhat concerning, since not all participants scored well in the *knowledge of climate change and related issues* test (discussed in section 4.2). If participants who scored low in the knowledge tests are in positions, where they are expected to apply their knowledge of climate change and related issues to make decisions, there is a risk of maladaptation. The alternative here is that participants may have quite specific knowledge of climate change, but only relevant to their area of work and not to broader issues. These results may also indicate that organisations have identified the need to respond to climate change, but perhaps they do not know how to, which is why they might send their staff on these training-courses.

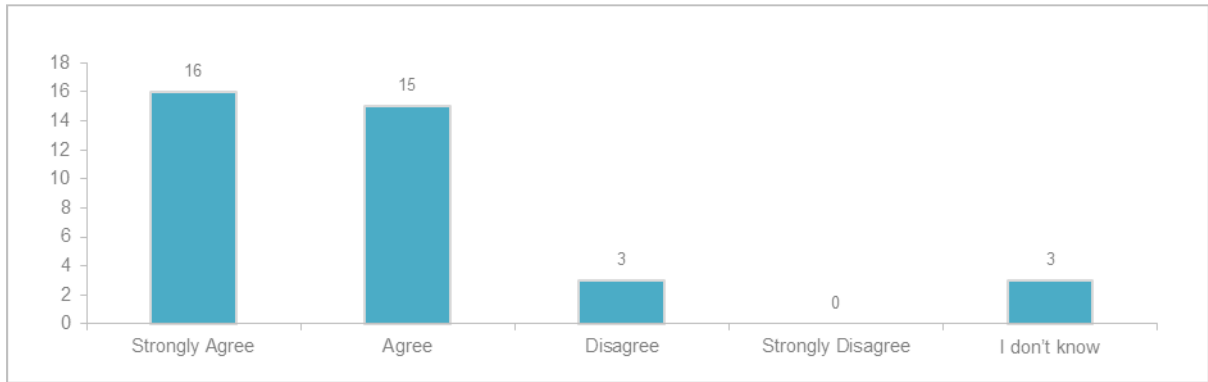


Figure 9: Participant responses to the statement “It is expected that I apply knowledge of climate change when making decisions at work.”

Responses shown in Figure 10 show that the majority of participants did not feel there was too much pressure placed on them to include climate change issues in their job. 27 participants (n=37) responded that they do not feel too much pressure to include climate change issues in their workplace, whilst 9 participants felt that they did have too much pressure placed on them. This question was asked in order to gauge participant attitude towards the inclusion of climate change issues in their workplace. Responses show that the majority of participants have positive attitudes towards including climate change and related issues in their job, and do not feel too pressured to do so. Participants who responded that there is too much pressure on them may not have a negative attitude towards climate change, but may believe that the response needed in their workplace requires a team response, and perhaps they are lacking that support. Alternatively, participants may feel that there is too much pressure on them to react, but this could be because there is genuinely a lot to do, and not because they feel climate change is unimportant.

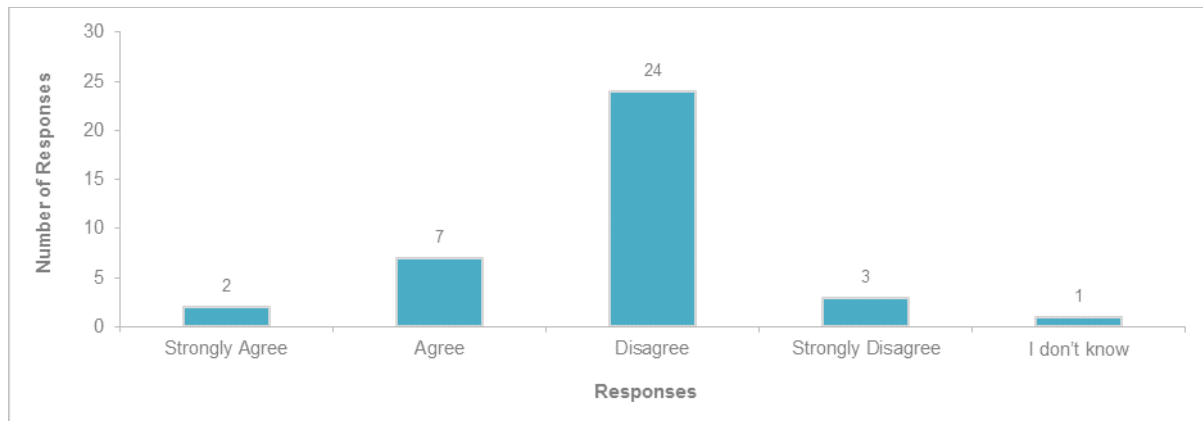


Figure 10: Participant responses to the statement “When it comes to climate change issues, I feel there is too much pressure on me to include the issue in my job.”

4.2 Changes in knowledge

In order to assess statistically whether there was any significant change in overall participant knowledge scores before and after training, paired t-tests were conducted on the survey data (Table 3). The paired t-test produced a t-value of 4.2716, with a P-value of 0.0001 (n=37). Thus, the difference between the pre-and-post training knowledge scores are extremely statistically significant. This means that the knowledge scores achieved after the training-course took place were very different to the scores achieved before the training took place. The paired t-test results show that overall; the knowledge scores post-training were significantly different to the pre-training knowledge scores. In order to determine the direction of change, the means of each data set were calculated and compared (Table 4).

Table 3: Results of the paired t-test conducted on the pre-and-post training survey data.

Element	Value
Two tailed P-value	0.0001
T-value	4.2716
Degrees of freedom	36
Standard error of difference	0.4688
Sample size (n)	37

Table 4: Mean and standard deviation results for the paired t-test conducted on the pre-and-post training survey data.

Element	Value
Pre-training mean knowledge score	15.49
Post-training mean knowledge score	17.49
Pre-training standard deviation	2.68
Post-training standard deviation	2.34

Table 4 shows the mean score before the training-course took place was 15.49 with a standard deviation of 2.68; the post-training mean was 17.49 with a standard deviation of 2.34. Therefore, comparison of the mean scores shows that the average score in the post-training test was higher than the average pre-training test score. Therefore on average the participants experienced a significant change in their knowledge scores, with the change in the positive direction. One can conclude that on a general level, participant's attendance of the climate change training-course resulted in an improvement of their knowledge of climate change and related issues. The graphs and analysis that follow explore the observed knowledge change in more detail.

The graph in Figure 11 shows that 25 participants (68%; n=37) achieved better scores in the post-training knowledge test than they did in the pre-training knowledge test. Another 5 participants had no change in their knowledge score in the post-training knowledge test, and 7 participants achieved lower scores in their post-training knowledge test. Two participants tied with achieving the best-improved score, with a 70% personal improvement in their scores (**blue** encircled in **green**). The steepest knowledge decline occurred in participant number 21 (**orange** encircled in **red**), where the participant achieved a post-training knowledge score that was 32% less than their pre-training knowledge score. The range of knowledge change varies from a decline as low as -32%, to improvement as high as 70%. The average knowledge improvement score, which takes all scores into account, is 15%.

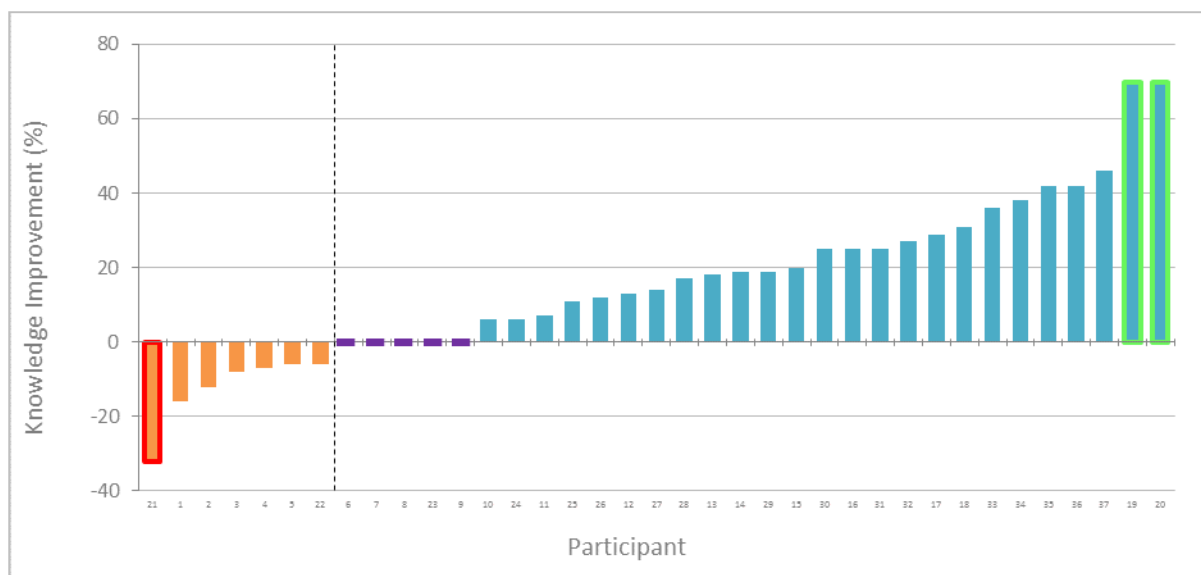


Figure 11: Shows the improvement, decline, or stability in participant knowledge scores, after attending a training-course. The blue bars represent individuals who showed improved knowledge scores in the post-test, whilst the orange bars show individuals who had their knowledge scores decline in the post-test. The x-axis represents each participant (n=37) and the y-axis shows the percentage of improvement or decline.

The knowledge test that the participants completed pre-and-post training was divided into two sections. The first section required that participants read two graphs pertaining to temperature and rainfall (historical data and future projections) and answer subsequent questions based on these graphs (Appendix C). Figure 12 shows the overall improvement in participants' ability to read these graphs and answer the questions correctly. Overall, participants were able to read graphs more accurately, but the improvement was not high. Before the training took place the total number of correctly answered graph questions was at 51%, after training took place the percentage of correctly answered graph questions increased to 58%. With initial accuracy at 51%, and an improvement of only 7%, the results suggest that participants are still not able to read climate related graphs with high accuracy.

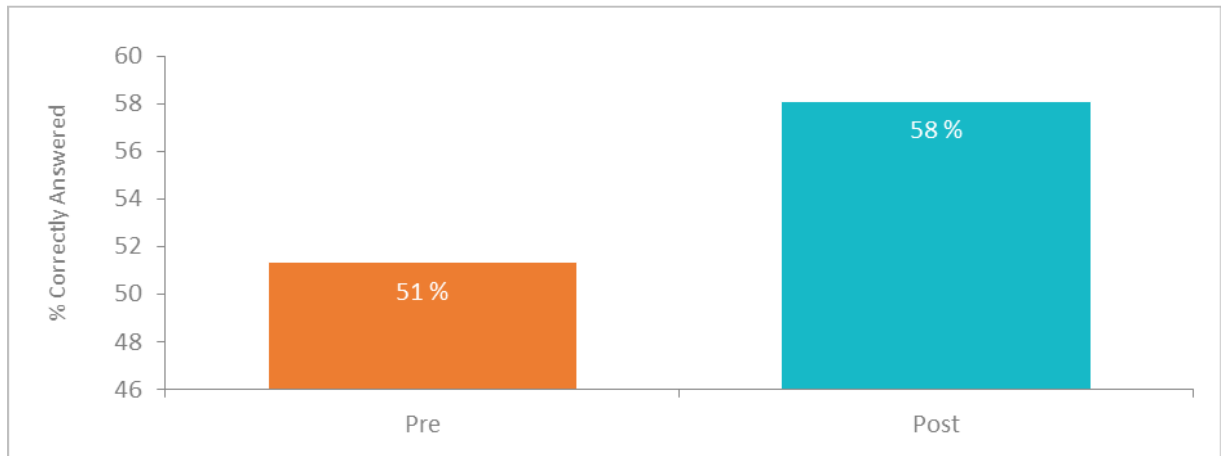


Figure 12.1: Shows participant ability to read temperature and rainfall graphs (historical and future projections). The orange bar represents the percentage of overall correct answers before the training-course took place. The blue bar represents the overall percentage of correct answers achieved after the training-course took place.

The second section of knowledge questions completed by the participants was a set of 11 True or False questions. Figure 12.2 shows that the number of correctly answered True or False questions improved from 63% in the pre-training knowledge test to 72% in the post-training knowledge test. There was therefore an overall improvement in correctly answered True or False questions of 9%.

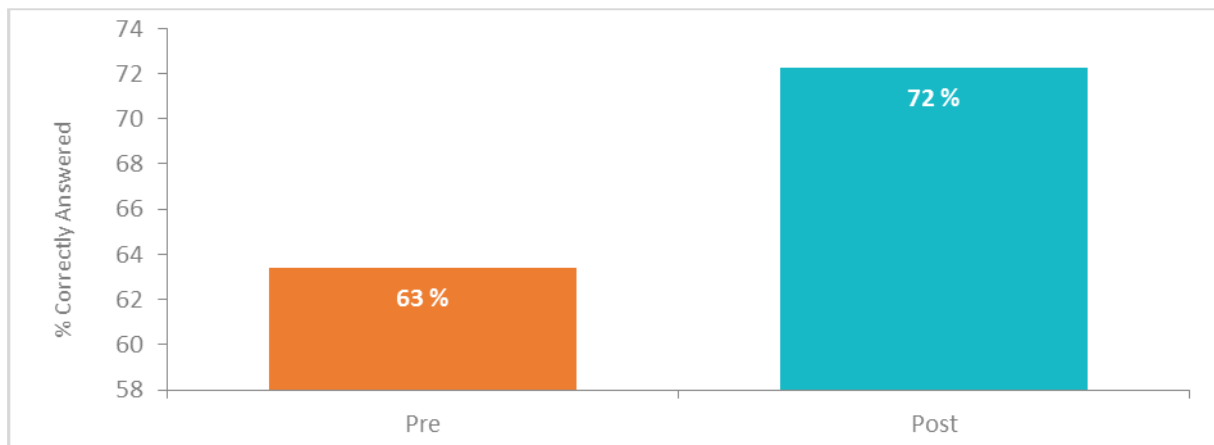


Figure 12.2: Correctly answered True or False questions.

Figure 13 shows how participants performed in specific True or False questions by subtracting the number of correct answers in the pre-test from the number of correct

answers in the post-test. Figure 13 is therefore able to show which questions participants improved on the most, and which they did not improve on.

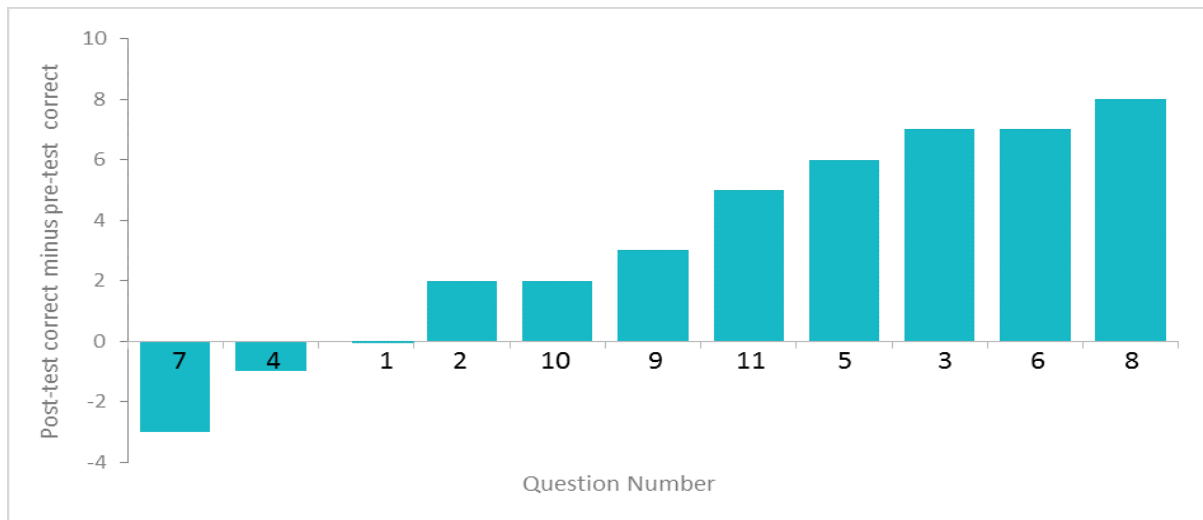


Figure 13: Specific results for each true and false question.

Figure 14: Question key for the numbered true and false questions shown in Figure 13.

#	TRUE AND FALSE QUESTIONS	CORRECT ANSWER
1	Mitigation of greenhouse gases is about reducing the amount of carbon dioxide and other specific gas emissions in the atmosphere.	TRUE
2	Climate is average weather.	TRUE
3	Climate model projections are accurate because they are able to explore and quantify all sources of uncertainty.	FALSE
4	Climate change is defined as any change in climate over time, whether due to natural variability or as a result of human activity.	TRUE
5	Adaptation to climate change is about reducing the impact of climate events.	TRUE
6	Climate change is now unavoidable, and will be long lasting.	TRUE
7	Probabilities in climate models reflect the level of uncertainty that climate scientists have as to whether climate change is happening.	FALSE
8	Differential heating of the globe results in energy transfer which together with the spin of the earth and position of the continents gives rise to our weather systems as we know them.	TRUE
9	Climate models only include the processes that are very well understood.	FALSE
10	A certain amount of global warming is now unavoidable, due to gases that are already present in soils.	FALSE
11	Decision-making on the basis of historic climate is robust.	FALSE

Regarding question 7, which relates to climate models and probabilities, results show that more participants answered this question incorrectly in the post-test than they did in the pre-test. A similar trend occurred to a lesser degree in question 4, which tested participant knowledge of the definition of climate change. Participants improved most on question 8, which tested participant knowledge of the dynamics of the earth’s weather system. Participants also improved significantly in terms of answering question 6 correctly, which related to climate change and it’s impacts; and question 3, which tested knowledge on climate models.

The total number of “I don’t know” responses decreased from 52 in the pre-test to 21 in the post-test (Figure 15). This means that participants were half as likely to respond to a climate change related question with “I don’t know” in the post-training knowledge test, compared to when they completed the pre-training knowledge test. This may be an indication that participants felt more knowledgeable and confident to answer questions on climate change and related issues after attending the training. If so, participants may feel more inclined to apply their knowledge of climate change in the workplace, as they have a belief that they know about the topic.

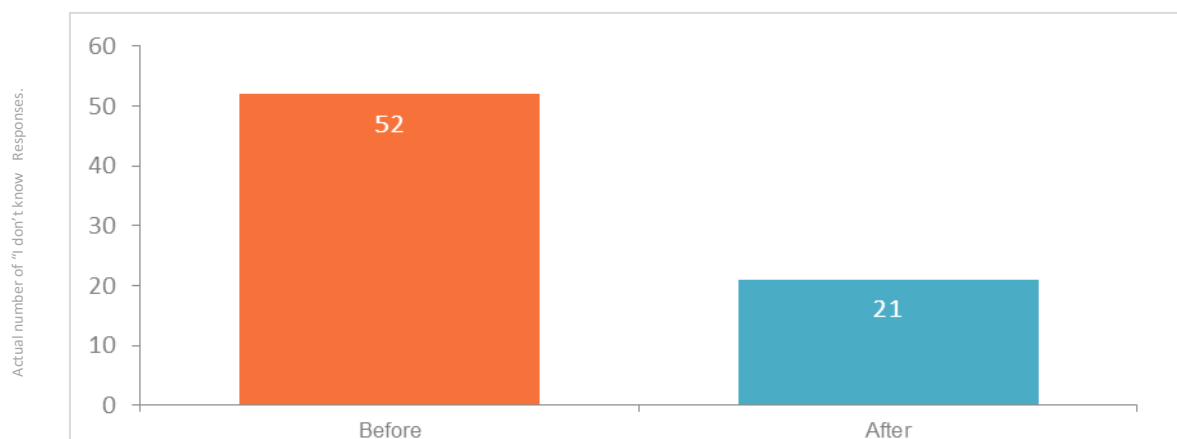


Figure 15: The total number of “I don’t know” responses in the knowledge section.

The first objective of this thesis was to determine the effect of the training-courses on participant knowledge of climate change and adaptation. Results show that on average, knowledge scores post-training are significantly different to the pre-training scores and

furthermore, the mean knowledge score of the post-training is higher than the mean knowledge score achieved in the pre-training. The majority (81%) of participants either experienced an increase in their knowledge scores or no change in their knowledge scores after attending the training-course. Not many peer-reviewed studies exist, pertaining to the effect of training-courses on participant knowledge of climate change and adaptation. An early study by Armstrong and Impala (1991) also conduct a pre and post course analysis, on the topic of environmental issues. In their case the authors found that student's environmental awareness and environmental knowledge scores were higher in the post-course test than they were in the pre-course test (Armstrong and Impala, 1991). However, due to the specific nature of the questions asked in the test of material delivered, it is hard to compare.

4.3 Perceptions and attitude

In order to assess, statistically, whether there were any changes in the perceptions and attitudes of the participants before and after the training-course took place, paired t-tests were conducted on the survey data. The results can be found in Table 6. The paired t-test conducted on the before-and-after perceptions and attitude response data shows that there is statistical significance in the difference in responses.

The next few graphs relate to participant's own perceptions of their understanding and knowledge of climate change and related issues. Figure 16 is represents participant self-reported knowledge of climate change science, as reported before and after the training-course. The response options were: *Not at all informed*; *Not very well informed*; *Fairly well informed*; *Very well informed*; and *I don't know*. There were no changes in the participant's perceptions of their current understandings. The *Not very well informed* category choice reduced from 5 responses to 2 responses, which is an improvement; and the *Very well informed* category increased from 2 responses to 8 responses, which is also an improvement. The total number of *Not very well informed* responses went from 5 responses to 2 responses and the *Not at all informed* response remained the same. The total number of *Fairly well informed* and *Very well informed* responses increased from 30

responses to 34 responses. Lastly, the *I don't know* response went from 1 response to 0 responses.

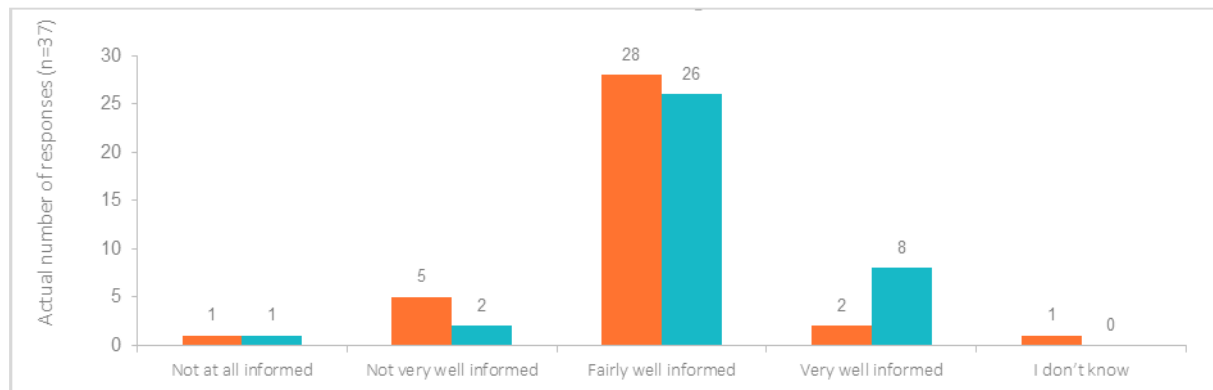


Figure 16: Shows the responses to the question: How would you rate your current understanding of the science that supports climate change?

In order to compare the participant's **perceptions** (Figure 16) of their knowledge with their **actual** knowledge scores (Figure 11) (assuming that the knowledge score achieved is an accurate representation of participant's actual knowledge of climate change), participant responses from Figure 16 were colour coded onto Figure 11 to create Figure 17. The length of the bars in Figure 17 represents the percentage value of knowledge improvement/decline for each participant. Figure 17 shows mostly orange bars, which therefore shows that most (28 of 37 or 76%) of the participants' perceptions of their own understanding of climate change post-training do not correspond with their actual knowledge improvement. This could mean that participant's under and over-estimate their own knowledge on climate change, and/or what they learnt on the training-course.

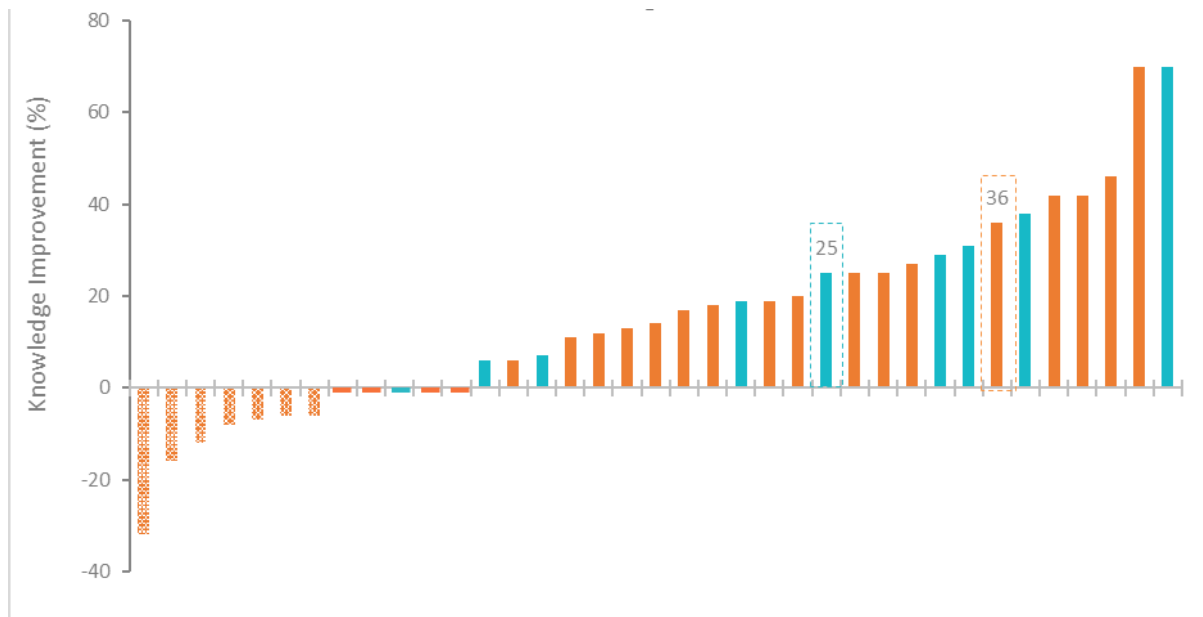


Figure 17: Participant perceptions of their knowledge improvement versus actual knowledge score improvement. The length of the bars represents the percentage value of knowledge improvement/decline for each participant. **Blue** bars represent participants who accurately identified their knowledge change. **Orange** bars represent participants who did not accurately self-report their knowledge change i.e. their perception of change in knowledge did not match their actual change in knowledge. Bars with orange cross-hatching over estimated their scores, solid orange bars under-estimated their scores.

Table 5 shows that the paired t-test produced a T-value of -2.4282, with a P-value of 0.0203 (n=37). By conventional criteria the difference between the pre-and-post training perceptions and attitude responses is considered to be statistically significant. The paired t-test results show that overall; the scores post-training were statistically different to the pre-training scores. The mean scores (Table 6) show that the average score in the post-training survey was higher (33.24) than the average pre-training score (31.78).

Table 5: Results of the Paired t-test conducted on the before-and-after survey data.

Element	Perceptions and Attitude
Two tailed P-value	0.0203
T-value	-2.4282
Degrees of Freedom	36
Standard error of difference	0.601
Sample Size (n)	37

Table 6: Mean and Standard Deviation Results from the before-and-after survey data.

Element	Value
Pre Mean	31.78
Post Mean	33.24
Pre STD	4.83
Post STD	4.25

Figure 18 shows that out of the 37 participants, 23 experienced positive changes in their perceptions and attitude scores (62%), 4 participants experienced no changes, and 10 participants experienced a negative change (27%) after attending the climate change training-course. Although the majority of participants experienced a positive change, it is interesting that 10 participants completed the course feeling less positive about climate change and adaptation than they did before attending the course. This may be due to the way in which the content was framed and delivered to the audience.

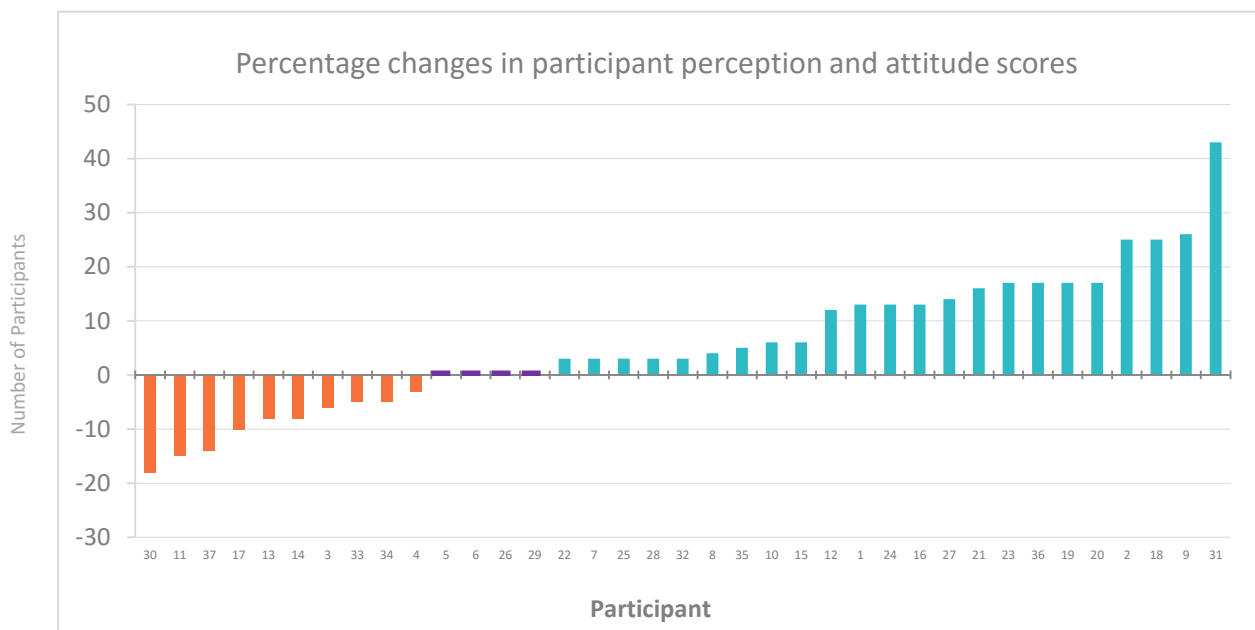


Figure 18: Participant perception and attitude change (in percentage).

Figure 19 shows the total number of participant “I don’t know” responses in the pre (before) and post (after) training survey. It is not surprising that compared to the number of “I don’t know” responses in the knowledge section (Figure 15), there are lower numbers in the perception and attitude section, since these are similar to opinions. However, the total number of “I don’t know” responses halved in the post-training survey, compared to the

pre-course survey. This means that 50% of the total “I don’t know” responses transformed into an opinion, after attending the training-course.

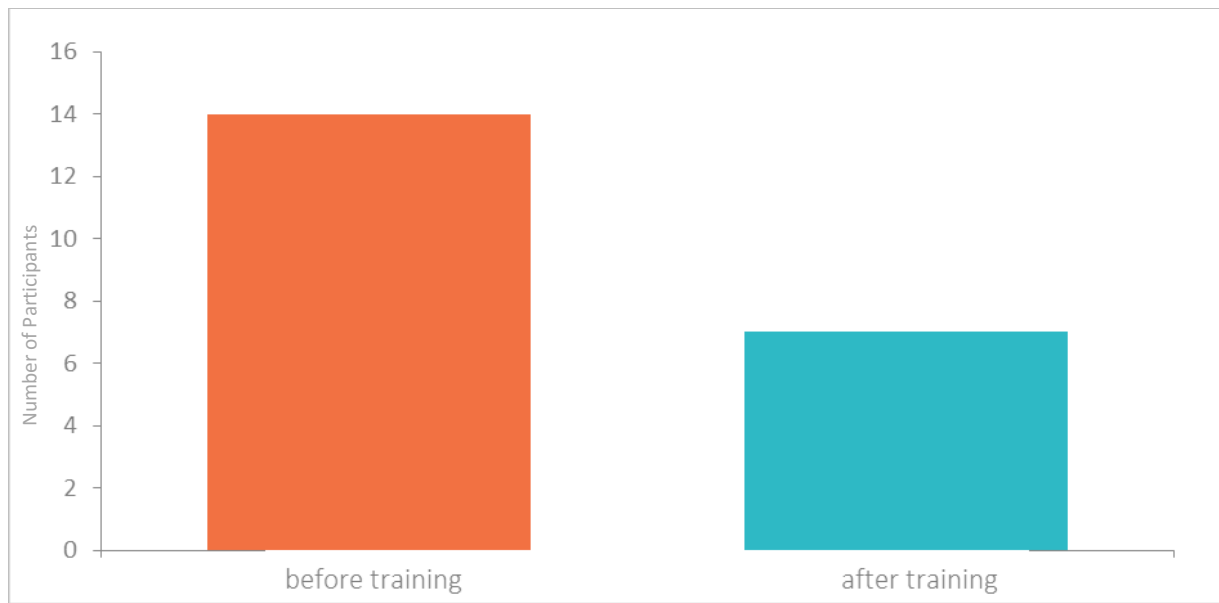


Figure 19: Total number of “I don’t know” responses to perception and attitude questions before and after the training-course took place.

The following section unpacks the detail of the changes in perceptions and attitudes experienced by the participants, arranged by categories “Addressing Climate Change in the Workplace”, “Adaptation and Mitigation” and “Uncertainty and climate change”.

4.3.1 Addressing Climate Change in the Workplace

Since the participants who attended the climate change training-courses were generally planners and decision-makers (who largely worked in the government sector) it was important to ascertain before the course started, to what degree they were already thinking about and making decisions relating to climate change mitigation and adaptation. The questions were therefore framed in order determine if participants were already engaging with climate change in their respective workplaces.

Figure 20 shows the responses to a question, which attempts to gauge how capable participants consider themselves, in coming up with ideas that can actually be applied in their workplace to reduce greenhouse gas emissions. This question was aimed at testing

participants' perceptions of their own ability to decrease greenhouse gas emissions, by taking action and making decisions in their workplace.

In the pre-test, 34 out of 37 participants agreed that they could think of changes they could make in their workplace that could result in the reduction of greenhouse gas emissions. In the post-test, there remained 34 participants who agreed they could think of such solutions, but the distribution between *Strongly Agree* and *Agree* changed, with fewer people stating that they *Strongly Agree* in the post-test. The number of *Disagree* responses decreased from 1 in the pre-test to 0 in post-test. These results show that most of the participants who attended the training-courses believed (both before and after the training took place) that they knew how to reduce greenhouse gas emissions in their workplace. This is interesting since only 5 participants felt it was expected of them as part of their work responsibility.

The *I don't know* response increased from 1 in the pre-test to 3 in the post-test. The increase in *I don't know* responses could suggest one of two things. Either participants were left somewhat confused by this question after attending the training-course, or they had a newfound clarity of what a reduction in greenhouse gases means. If participants left the course feeling confused, it may indicate a problem with the way in which the course content was framed, and communicated (Morton et al, 2011). In their 2011 paper, Morton et al. explain that communication efforts can trigger confusion, along with disengagement, defensiveness, and even denial. The concern here is that these feelings can result in inaction, which is contrary to the aims and objectives of the training-course (Morton et al., 2011).

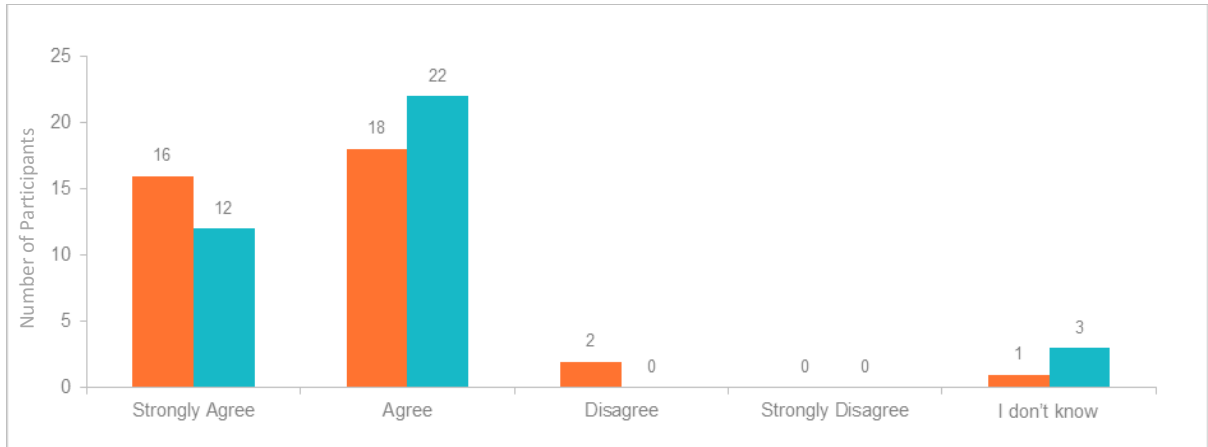


Figure 20: Shows participant responses to the statement “With regard to my job responsibilities, activities, and key performance areas, I can think of changes that I could make that would result in a reduction of greenhouse gas emissions”. Orange bars show the pre-test responses whilst blue bars show the post-test responses.

Following the question of whether or not participants could think of ways to reduce greenhouse gas emissions in their workplace (Figure 20), participants were asked a question which attempted to gauge whether or not they felt they could apply their knowledge (current or learnt) of climate change in their workplace. This question was asked in two forms, one referred to the relevance of climate change information (Figure 21), and the other referred to the complexity of climate change information (Figure 22).

Responses show that participant perceptions of being able to apply climate change information in the workplace did not change very much after training. The majority of participants felt that they could apply knowledge of climate change in their workplace before attending the training-course, and their perception remained so after attending the training-course.

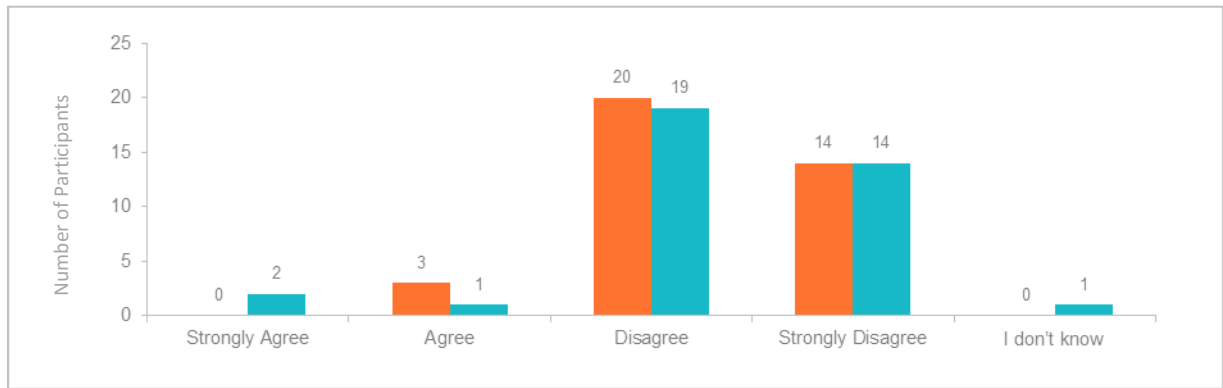


Figure 21: Shows participant responses to the statement “I don’t see how I can apply knowledge of climate change in my workplace; the information is interesting but not relevant to my job”. Orange bars show the pre-test responses whilst blue bars show the post-test responses.

As can be seen in Figure 22, the majority of participants (pre-test: 23; post-test: 25; n=37) do not think that climate change information is too complex to include in the their workplace. The “Strongly Disagree” response increased from 2 in the pre-test, to 7 in the post-test. Therefore, 5 individuals changed their perception that climate change information is too complex to apply in the everyday work place. The number of “Strongly Agree” responses decreased, and the number of “Agree” responses increased, but only by 1 response. The number of “I don’t know” responses reduced from 2 to 0. The responses shown in Figure 20 may indicate that, compared to the issue of relevance of applying climate change information in the workplace, the complexity of the information may be the more dominant barrier to actually being able to apply climate change information in the workplace.

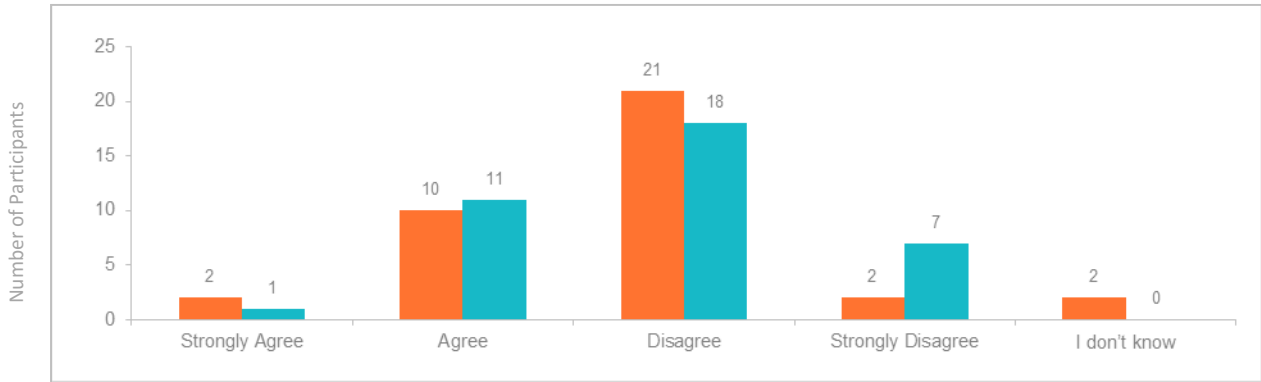


Figure 22: Shows participant responses to the statement “Climate change information is interesting, but it is too complex to apply to the everyday workplace”. Orange bars show the pre-test responses whilst blue bars show the post-test responses.

In order to gauge whether or not participant’s attitude towards applying climate change information in the workplace was influenced by attending the training-course, participants were asked if they would like to include climate change information more in their work (Figure 23). The number of “Strongly Agree” responses increased by 4 responses (from 12 responses in the pre-test, to 16 in the post-test). The number of “Agree” responses decreased from 22 in the pre-test to 17 in the post-test. The number of “Disagree” and “Strongly Disagree” responses both decreased in the post-test. 2 of the “Agree” responses that changed after training changed to the “I don’t know” category, and the remaining 3 were changed to “Strongly Agree”. Only 1 of the “Disagree” responses changed to an “Agree” response. Overall, not much changed in terms of participant’s desire to include climate change issues more in their workplace. Overall, the majority do want to include more climate change issues in their workplace.

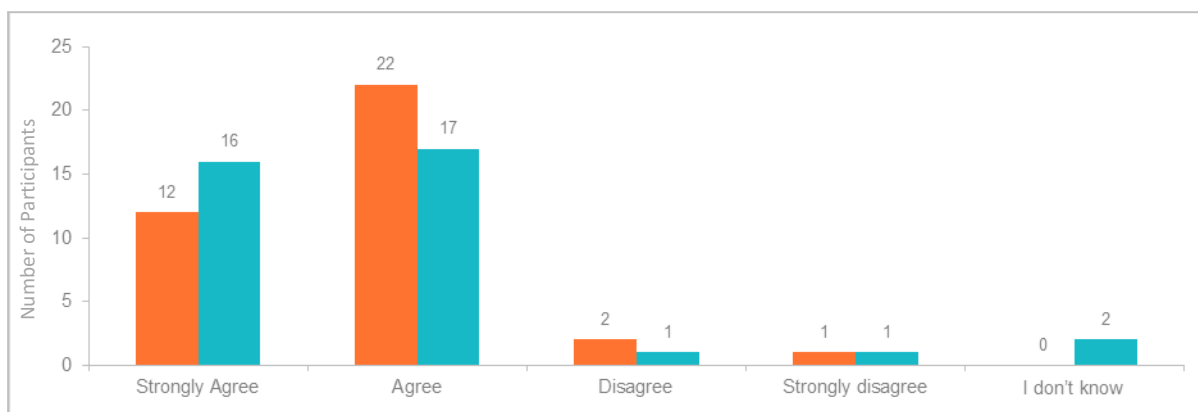


Figure 23: Participant responses to the statement “I would like to include climate change issues more in my work”. Orange bars show the pre-test responses whilst blue bars show the post-test responses.

A few conclusions may be deduced from the above responses in terms of participant perceptions and attitudes towards addressing climate change in the workplace. Firstly, participants do believe that they know how to make changes in the workplace that can reduce greenhouse gas emissions. Secondly, they feel that they can apply climate change information to their workplaces, and thirdly, participants feel (before and after training) that they do want to include climate change issues in their workplace, more than they are currently doing. The finding that suggests that participants want to address climate change issues in their workplace is valuable, given that intention has been shown to be the most important variable in predicting behaviour (Godin and Kok, 1995).

4.3.2 Adaptation and Mitigation

The following graphs show the pre-and-post training-course participant responses, in relation to adaptation and mitigation. The aim of these questions was to ascertain what affect the training-courses had on participant’s perceptions of and attitudes towards adaptation versus mitigation. It is important to note that the course content focused more on adaptation.

Figure 24 shows the response to the statement of whether participants perceive that the reduction in greenhouse gas emissions (i.e. mitigation) is the *primary* way in which government should approach the issue of a changing climate. Overall, both the pre-and-post-test participants (pre-test: 27; post-test: 26; n=37) agreed that mitigation is the primary way in which government should approach the issue of climate change in order to reduce the negative consequences thereof.

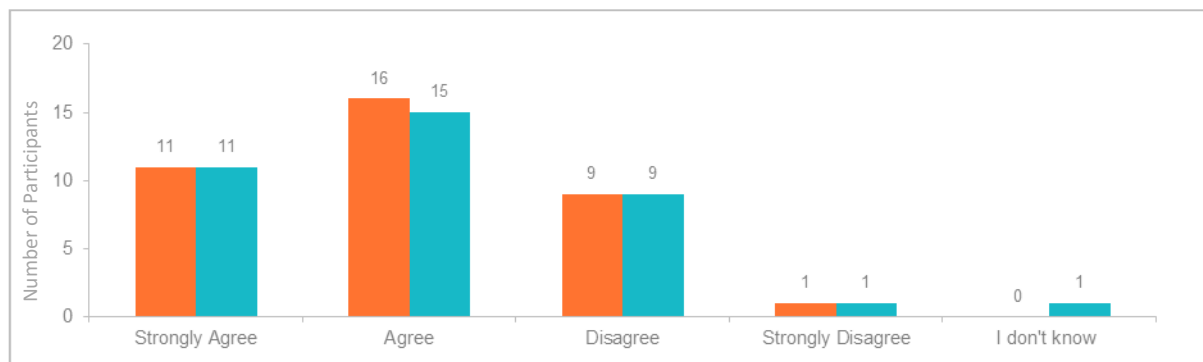


Figure 24: Participant responses to the statement “Reduction of greenhouse gas emissions is the *primary* way in which government should approach the issue of a changing climate, in order to reduce the negative consequences thereof”. Orange bars show the pre-test responses whilst blue bars show the post-test responses.

Participants also responded to a question, which asked if, contrary to the statement in Figure 24, adaptation should be prioritized over mitigation (Figure 25). In the pre-test 13 participants agreed, 10 participants disagreed, 4 participants with “I don’t know”, and 10 participants specified “Other” and stated that both need to be prioritised. In the post-test, 16 participants agreed, 13 participants disagreed, and 8 specified that both need to be prioritised in the “Other” field. The “I don’t know” response reduced from 4 to 0. Therefore, participants who had originally responded with “Other” and “I don’t know” changed their responses to a more agreeable or disagreeable responses. There was no overwhelming agreement in terms of the way participants responded to this question in the pre and post-tests. Although some change did occur, participant responses remained fairly evenly split (agree: 16; disagree: 13; n=37).

These results are interesting when compared to responses in Figure 24, where the majority of participants (pre-test: 27; post-test: 26; n=37) responded that mitigation is the primary way in which government should be addressing the issue of climate change. If participants perceive mitigation to be the primary way in which government should address climate change (as shown in Figure 24), then one would expect responses to the statement in Figure 24 to be more disagreeable, and less evenly spread. These results could point to a number of scenarios. Participants might have been completing the questionnaire without putting much thought into their responses, responding in a way that they *thought* they should respond, they might be undecided on the issue, or they may not understand the differences between adaptation and mitigation. However, it may well be that participants feel strongly about both mitigation and adaptation, and can't choose one over the other.

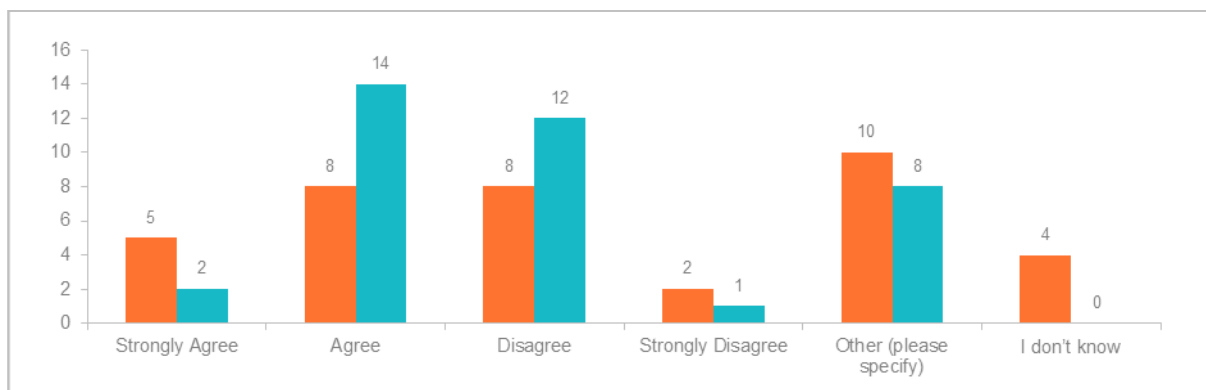


Figure 25: Participant responses to the statement “It is now more important to focus on climate change adaptation rather than on reducing greenhouse gas emissions”. Orange bars show the pre-test responses whilst blue bars show the post-test responses.

Figure 26 shows the pre-and-post training-course responses to a statement, which tries to ascertain how participants think government should prioritize climate change, in terms of resource allocation. Participant responses did not change much in this regard, however, most participants responded with “Strongly Agree” and “Agree” (35, n=37) in both the pre-and-post-test.

The responses to this statement shows that 95% of participants (many of whom work in government themselves) believe that government need to prioritize adaptation more than they are currently doing, even if government may need to allocate more resources to the

issue. The findings suggest that participant’s perception of current efforts by government to address climate change and related issues are lacking. Since participant responses did not change much in the post-test, one could confer that participants attended the training-course with this perception, and this perception remained. Interestingly, the training-course did not amplify any responses in participant agreement (i.e. no responses changed from “Agree” to “Strongly Agree”) that government should be making more effort and allocating more resources towards addressing climate change, as might have been expected.

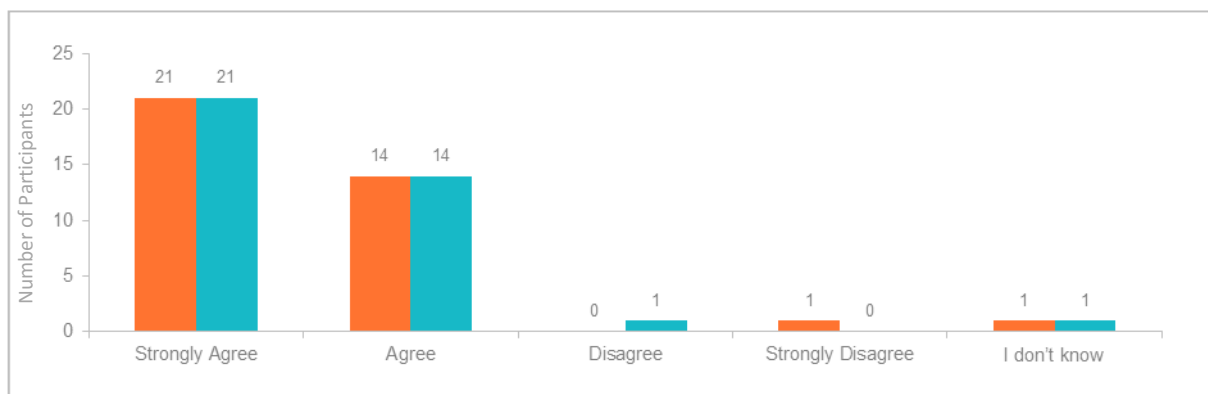


Figure 26: Participant responses to the statement “I think that governments need to prioritize adaptation more than they are currently doing, even though this mean allocating more government resources to the issue”. Orange bars show the pre-test responses whilst blue bars show the post-test responses.

4.3.3 Uncertainty and Climate Change

The following section reports and discusses participant responses to statements posed in order to gauge participant perception of uncertainty in climate change. Figure 27 shows that in the pre-test the majority of participants (84%, n=31) responded that the uncertainty behind climate change impacts made them feel that other issues should be prioritised over climate change issues (“Strongly Agree” or “Agree”). In the post-test, this number reduced to 28 (76, n=37). The number of “Disagree” and “Strongly Disagree” responses increased from 6 in the pre-test, to 9 in the post-test. The results shown in Figure 27 may be indicative of a number of other issues. Given that 84% of participants agreed with the statement, it may indicate that a large proportion of participants are not fully convinced, or perhaps aware of, the interconnectedness of climate change and the impact it can have on multiple

systems. The results of shown in Figure 27 may be indicative of a lack of understanding of how climate change affects issues of food security, water availability and the spread of infectious disease.

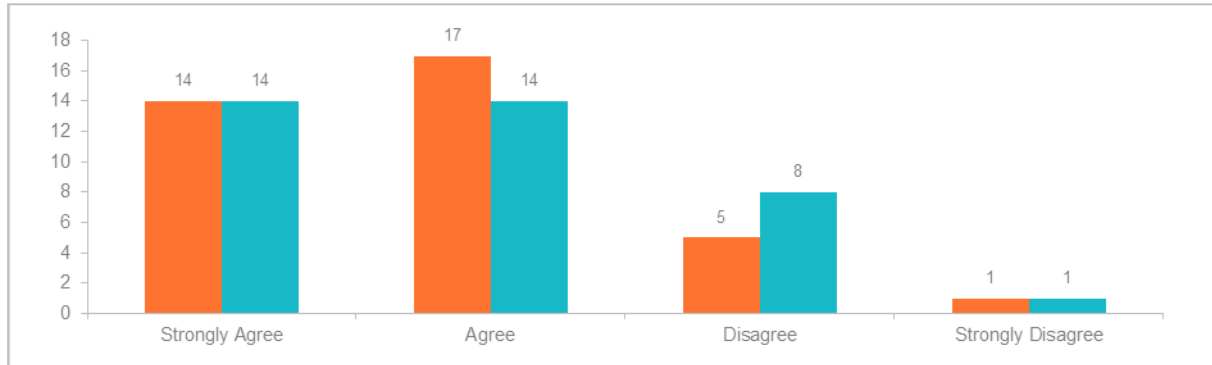


Figure 27: Participant responses to the statement: “Given the uncertainty around potential impacts of climate change, I feel that other issues like lack of food and clean drinking water, and the spread of infectious disease should be prioritized” (orange bars represent the pre-test results whilst blue bars represent the post-test results).

Figure 28 shows responses to a statement aimed to gauge participant perceptions of uncertainty of climate models, specifically using a tool for prediction and planning. In the pre-test 7 participants agreed that climate models should not be used as a tool for prediction and planning, and 24 disagreed (65%, n=37). In the post-test, 5 participants agreed that climate models are too uncertain to use for prediction and planning, and 31 disagreed (84%, n=37). These results indicate that participant may understand climate models better after attending the training, and therefore understand how they can access, use, and integrate the model outputs and information into their work. During the course, participants were taught how to use CSAG’s Climate Information Portal (CIP), which is an interactive and user-friendly tool for accessing both historical and future (downscaled projections) climate data. In the interviews participants stated that learning how to use CIP, and knowing that they could take this newly learnt skill and apply it to their workplaces, was an invaluable component of the training-course.

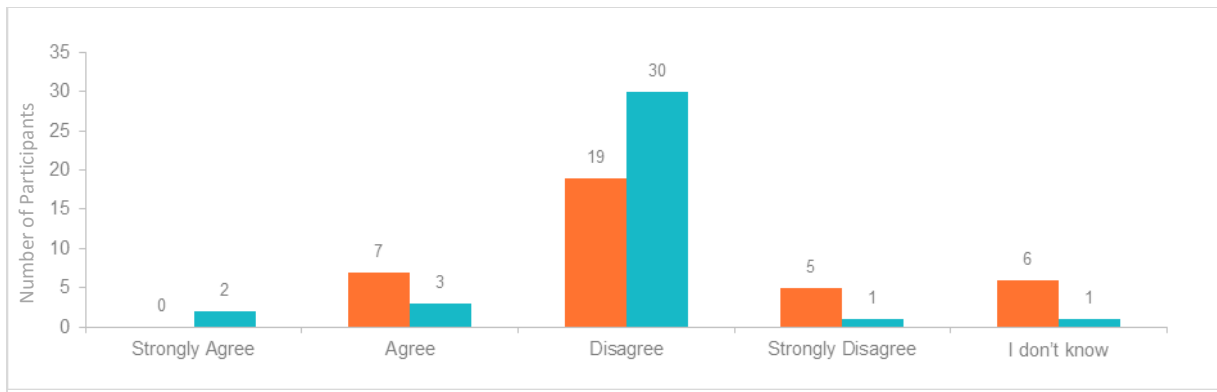


Figure 28: Shows the responses to the statement “Climate models are too uncertain to be used as a tool for prediction and planning”.

4.4 The relationship between knowledge, perceptions, and attitude

The Pearson correlation coefficient was calculated in order to determine if the knowledge scores correlate with the perception and attitude scores. This was done for the pre-test scores as well as for the post-test scores.

4.4.1 Pearson Correlation Results

The pre-test comparison produced an R-value of -0.0388 The R² coefficient of determination is 0.0015. The subsequent P-value is 0.823308 at $p < 0.05$. Therefore, the relationship between the pre-test knowledge scores and perceptions and attitude scores is weak, and not significant at $p < 0.05$. The same correlation test was conducted for the post-test knowledge, attitude and perceptions scores. The R-value is 0.1415, which is technically a positive correlation, but the relationship between the variables is weak. The R² coefficient of determination is 0.02. The subsequent P-value is 0.403501. The result is not significant at $p < 0.05$. Therefore, in the pre-test and post-test scores, the relationship between knowledge, perceptions, and attitude is very weakly correlated. This result is not significant at $p < 0.05$. The scatter plot in Figure 29 shows graphically the relationship between participant knowledge changes and changes in perceptions and attitudes, pre-and-post training. The **grey points** represent the pre- training-course scores, whilst the **orange points** represent the post training-course scores.

The x-axis represents the knowledge score of each individual before and after the training took place. The y-axis represents the perception and attitude score of each participant, also before and after the training-course. There is a shift in the positioning of the points, if one compares the positioning of the grey points to the orange points. The shift occurs towards the right and upward position. This corresponds with a general shift in the positive direction of higher knowledge scores (right-ward shift) and more positive perception and attitude scores (upward shift). However, the correlation is not significant, as was shown in the Pearson Correlation Results.

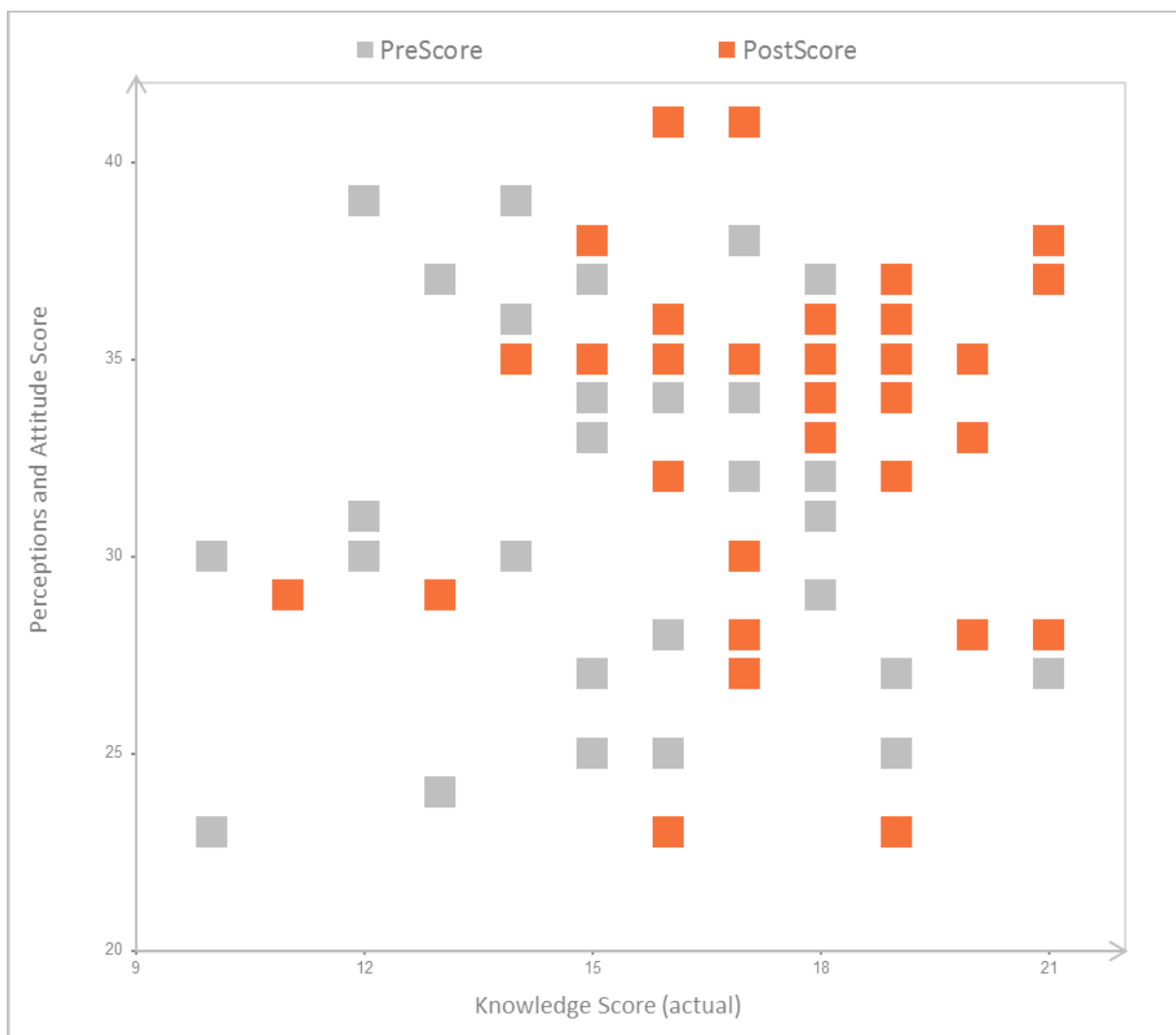


Figure 29: Scatter plot of knowledge scores (x-axis) versus perception and attitude scores (y-axis).

For both the pre-test and post-test scores, the relationship between knowledge, perceptions, and attitude is very weakly correlated and is not significant at $p < 0.05$. This

result is aligned with the large body of evidence reviewed by Allum et al. (2008). In their 2008 paper, Allum et al. reviewed evidence on the relationship between public attitudes and public knowledge about science across 40 countries to data from 193 nationally representative surveys carried out since 1989. The authors only found a small positive correlation between general attitudes towards science and general knowledge of scientific facts (Allum et al. 2008). Likewise, this thesis did not find a strong correlation between knowledge, perceptions, and attitudes; however, there were changes in knowledge and there were changes in perceptions. An alternative theory might be that simply attending a climate change and adaptation training-course affects participant perceptions and attitudes towards the issue.

5. Qualitative Analysis and Discussion

The following section describes and discusses the data collected using anonymous feedback slips and semi-structured interviews. As was outlined in the Methodology (Chapter 3), the findings from the feedback slips informed and guided the conversation in the semi-structured interviews.

5.1 Feedback slips

As described in the methods, opportunity to provide feedback anonymously was provided regularly. Table 6 shows the top 5 key words as reflected on the Like and Dislike feedback slips. Participants were able to write their likes and dislikes anonymously, but the process was voluntary so not everyone contributed to the population of the table. The top Likes mentioned on the feedback slips included games, exercises, presentations and lectures, interactive elements of the training-course, and the networking opportunities. On the Dislike slips, participants mentioned the cold temperature of the room, a rushed programme, the presentations, games, and case studies. The feedback slip responses were used to guide conversation in the semi-structured interviews. Although there were more positive feedback slips than negative, participants appeared to feel comfortable enough to express constructive criticism of the course during the actual interviews.

Table 7: Participant anonymous feedback slip responses.

Number of slips	Likes	Number of slips	Dislikes
52	Game	17	Cold Room
30	Exercises	13	Too Rushed
33	Presentations and Lecturers	5	Presentations
11	Interactive	5	Game
9	Networking	4	Case Studies
135	Total Slips	44	Total Slips

The previous chapter presented quantitative results, revealing evidence of change in participant knowledge and perceptions of, and attitudes towards climate change and

adaptation, after attending a training-course. In order to gain a deeper understanding of participant experiences at the training-course, semi-structured interviews were conducted.

5.2 Semi-Structured Interviews

This section analyses and discusses the findings from 14 participant interviews, highlighting a number of issues relating to the training-course that could not be discovered using purely quantitative methods of data collection. Five methods of communication and training emerged (with participants providing mixed responses) from the interview analysis, namely: PowerPoint™ Presentations, Games, Role-play, Exercises, and Group work.

In line with the fourth and final objective of this study, the sections that follow highlight methods of communication and training that participants found to be most effective in improving their understanding of climate change, adaptation, and related issues. Illustrative diagrams provide examples of participant direct quotes regarding different methods of teaching and communicating (Figures 30, 32, 33). These figures provide a visual means of displaying the frequency of mention. The horizontal bar lengths indicate the frequency in which the sub-category was mentioned, in relation to the category. For example, in Figure 30, titled “Lectures and PowerPoint Presentations”, the longest horizontal bar is blue and has the title “Good”. This means that the majority of interviewees who mentioned Lectures and PowerPoint Presentations during the interviews said that this component of the training-course was good. On the same diagram, a shorter orange horizontal bar has been labelled “Boring”. This shorter horizontal bar is roughly one third of the length of the “Good” bar. This means that interviewees mentioned that Lectures and PowerPoint Presentations were “Good” three times more frequently than the mention of them being “Boring”.

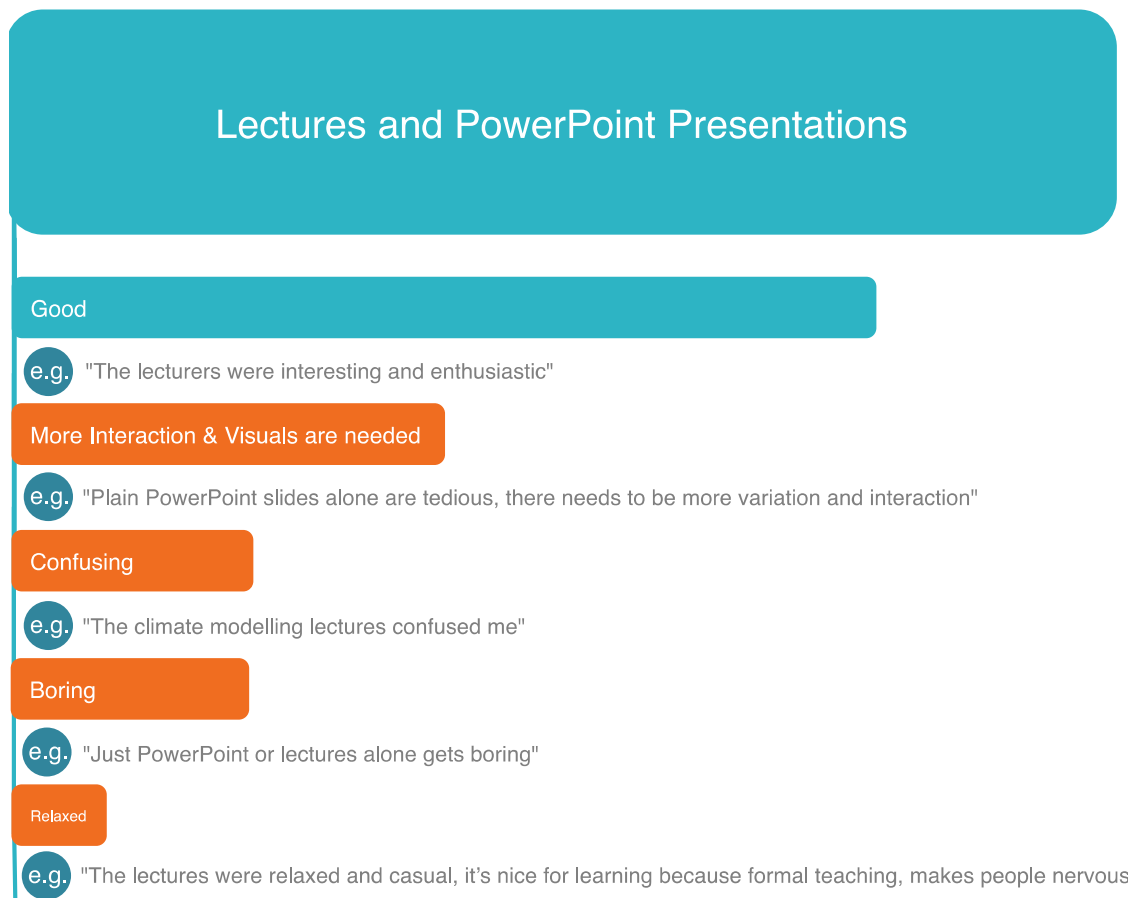


Figure 30: Examples of participant feedback on the way lectures and PowerPoint™ presentations were presented.

Although the training-courses were designed such that a range of teaching and communication methods were employed to deliver the content, the majority of the content was communicated and taught using PowerPoint™ presentation slides. Perhaps as a result, many of the participants had recommendations for how these lectures could be improved upon (Figure 31). These recommendations refer to both the content of the lectures and the presenters themselves, but highlight existing criticisms of PowerPoint™ presentations as identified in the field of education. Such recommendations and comments included:

"Plain powerpoint slides alone are tedious and need variation"

and

“It is bad when the lecturer just reads the powerpoint slides”

and

“One directional lectures are very boring”

There have been many studies, which explore the pros and cons of using PowerPoint™ to teach (e.g. Lowry, 1999; Szabo and Hastings, 2000; and Apperson, Laws, and Scepanzky, 2006). Driessnack (2005) found that PowerPoint™ presentations inhibit presenter–audience interaction, which was a strong criticism put forth by the participants in this study.

The participants recommended that more interactive exercises be embedded into the PowerPoint™ lecture sessions, and that more visuals be employed in presentations. Another strong request was for lecturers to speak slower, as not all participants were able to follow the lecturer when new terminology was introduced too quickly. Lecturers should recognise that participants may not all have English as their home-language, and therefore content needs to be explained using limited jargon and at slower speeds (Leggett and Finlay, 2001).

Despite the criticisms outlined above, many of the participants appreciated and valued the contribution of the PowerPoint™ presentations. Interviewees mentioned that:

“The powerpoints were good for explaining the climate system.”

and

“The lecturers were engaged and clear and kept the interest levels up.”

Studies by Lowry (2009), and Szabo and Hastings (2000) found that PowerPoint™ presentations improve learning, compared to standard lectures with no visual aids. Indeed, the participants in this study felt that the visual illustrations and video and sound clips embedded in the PowerPoint slides enabled them to understand complex content with more ease.

A further component of lectures and PowerPoint™ presentations identified by participants as enabling to their understanding of the content was the enthusiasm of the lecturers. Participants' felt that obvious lecturer enthusiasm helped them stay focused, and introduced a sense of interest in the content. A few participants mentioned that the relaxed and casual nature of certain lecturers was a calming influence, which enabled them to concentrate and learn. Other interviewees felt that the lectures and PowerPoint™ presentations were confusing, boring, and in need of more interactive components and visuals. Many participants mentioned that the climate-modelling lecture was extremely confusing. However, this session's content is known by CSAG to be more challenging compared to the other sessions.

Interestingly, the lecture that was mentioned most frequently, and with great enthusiasm, was the lecture given by the director of CSAG. This took place during a special lunchtime break and the participants were told prior to the lecturer's arrival that this person was a leading scientist in the field of climate change. Hence the participant's enthusiasm may have been in line with findings from Alvares et al. (2004), who suggest that the instructors themselves and the trust that learners have in them affect the degree to which participants engage in the classroom. Many participants stated that their favourite lectures were from two of the more popularly known, academically distinguished lecturers.

This could be due to a sense of respect they have for their well-established peers, or perhaps these lecturers are more experienced and therefore more engaged with students, since they are more experienced at lecturing and doing presentations to varied audiences. One of these two lecturers also presented a lecture on the philosophy of decision-making, which participants found was very eye opening and different to what they were used to hearing about. This lecturer was able to captivate the audience, even though the lecture took place over the participant's lunch break at a time one would expect them to be tired. The slides used in this lecture were very simple and were not key, but rather additive to his talk.

Many participants felt that a great positive of the training-course was the variety in topics being taught, and the variety of lecturers teaching these topics. Participants felt that when

different lecturers introduced different topics, this lecturer was the local expert on this topic. This was an assumption, probably made sub-consciously, but it meant that each session on a different topic was taken seriously, since it was felt that experts in the relevant fields were providing the lectures.

Games and Role-play

The overall impression of the games and role-play activities was a positive one and most of the interviewees praised the different games and role-playing activities.

Games allow learners to explore, try things out, and see the effect of their actions (Whitton and Mosely, 2012). Some of the interviewed participants identified games and role-play as a unique and memorable method of communicating climate change information, and enabling understanding (Figure 33).

“The roleplay was good for social aspects as it shows the challenges of using climate info.”

and

“The games will stay in my brain for a long time, they were memorable.”



Figure 31: Participants partaking in the “Decision-making pathways” game at Winterschool, 2015. (Source: authors own).

The majority of participants who mentioned games and role-play activities were positive about the experience, and praised the training-course organisers for bringing this experience to them. An example of this experience can be seen in Figure 31, where participants were photographed taking part in a game.

The most popular game mentioned was the “Decision-making pathways” game (Figure 31). This game requires that one participant be blindfolded, and this participant is then made to walk along a string that is spread across a room. The blindfolded participant must then listen to directions to follow the paths that are being shouted out to him/her by the rest of the participants. The blindfolded participant is not aware of an added dynamic where one participant has been told to shout out incorrect directions, extra loudly. Some participants felt that the games were simplified, but that this was necessary in order to get lessons across in the games. A few participants didn’t like the number of games that were in the programme, given the tight schedule and the amount of content that was covered. A few participants felt that the amount of time spent playing games, although they were content related, was too time consuming. A minority of participants felt that the games were child-like and it was annoying for them to be disrupted from their thought process for “breather” games.

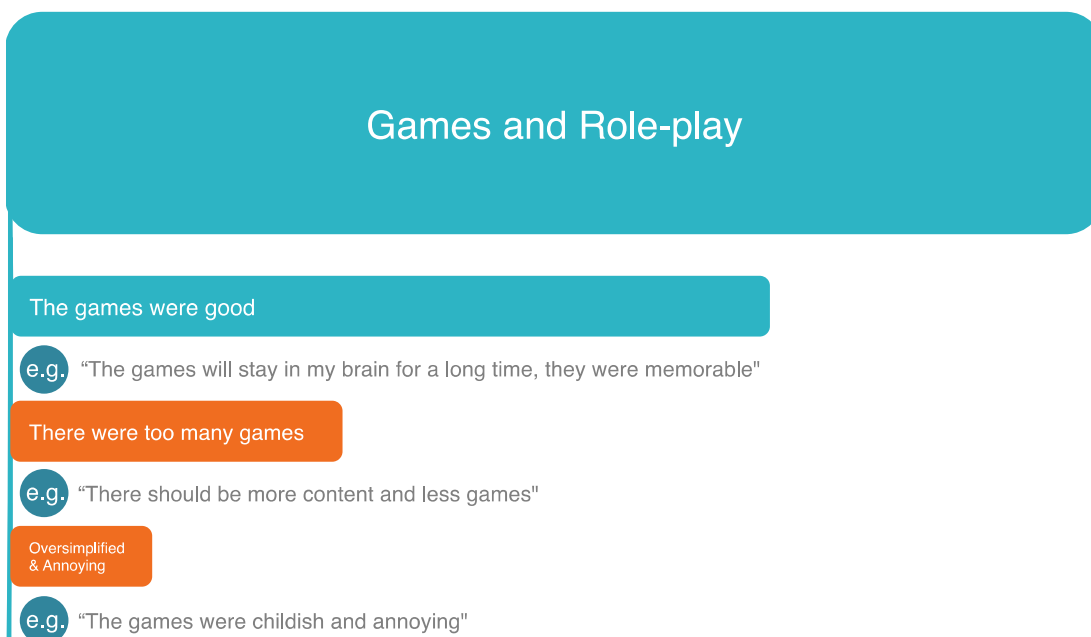


Figure 32: Examples of participant feedback concerning games (including role-play) as a method of communication and training.

Since a sufficiently vivid description allows listeners and readers to place themselves in the story, role-play activities can be very effective in encouraging experiential learning (Marx et al. 2007). Furthermore, events that have taken place in the past (such as playing a game) can induce emotions, which frequently makes one remember them, and therefore dominate when information is being processed (Slovic et al., 2002; Loewenstein et al., 2001). Therefore, games are a suitable option when the objective is to encourage experiential learning. Games allow participants to engage with content in meaningful ways, and can help them remember.

This study, however, suggests that games should to be very well explained beforehand, in order to reduce the perception that participant time is being wasted on non-teaching activities.

“Games distracted me when I was concentrating fine.”

The “breather” games were introduced in order to give the participants a rest mid-way through the more challenging lectures. Whitton and Moseley (2010) provide an explanation for this – since they argue that in order to have a positive effect on learning, there needs to be an appreciation of the purpose and value of the game, and intrinsic interest in the game subject matter for it to work (Whitton and Moseley, 2012).

Exercises and Case Studies

The exercise components of the training-course that required practical application were mentioned most frequently as a method that enabled understanding, during the interviews. In the instance of the CSAG training-courses, participants were taught how to complete a Risk and Vulnerability Assessment. Activities like these allow participants to experience how climate information can be used to improve their planning and decision-making abilities. Participants enjoyed learning new skills, and enjoyed the feeling of having learnt how to do something they couldn't do previously. The participants were primarily referring to the *Climate Information Portal*, as well as the “Climate Change Impacts, Risk and Vulnerability” ranking exercise. An example of the Risk and Vulnerability Ranking exercise can be found in Appendix D.

It is not surprising that the exercises and components of the training-course that required practical application were mentioned frequently as a method that enabled understanding. The Experiential Learning Cycle, developed by Kolb (1984) puts forward the idea that students learn better by discovering and engaging in experiences for themselves, and eliciting their own meanings and understandings from these experiences.

Group Work

Group work is known to promote experiential learning (McGraw and Tidwell 2001) and collaborative and cooperative learning (Ackermann and Plummer 1994; Lee et al. 1997; Mahenthiran and Rouse 2000; Nance and Mackey-Kallis 1997). Many participants found that working in a group was great for learning:

“It is not nice to learn on your own so workshop learning is nice.”

and

“The group work helped me hear about other peoples perspectives.”

and

“It was beneficial for me to be with the gurus in my team.”

Others found group work stressful because of particular members of their group who had louder opinions and more dominant voices than their own. One of the participants noted that the training-course was very male-dominated in general, and that this could have an effect on group work experiences.

Therefore, some interviewed participants felt that the group work was an opportunity to learn from others with variable levels of experience and background, and an opportunity to network. Interestingly, although the majority of interviewees mentioned that they enjoyed the networking aspects of the training-course, the participants who were interviewed were split roughly 50/50 in terms of their opinion of group work as a teaching method (Figure 34). Different interviewees had different experiences of the group-work component, some of

them complained that the groups were too large (5-6 people per group) making conversation and expression of different opinions difficult.

Others loved the group-work component and stressed how helpful it was to be placed in a group with experts in the field, who were able to explain concepts and details, which the interviewee was not able to grasp in the lecture session. Therefore, group work as a teaching method appears to work for some but not others, and it depends on the individual and the group within which they are placed. When working in a group, individuals with a range of knowledge, personal experience, and skills can share a diverse range of information and perspectives to come up with solutions to problems.

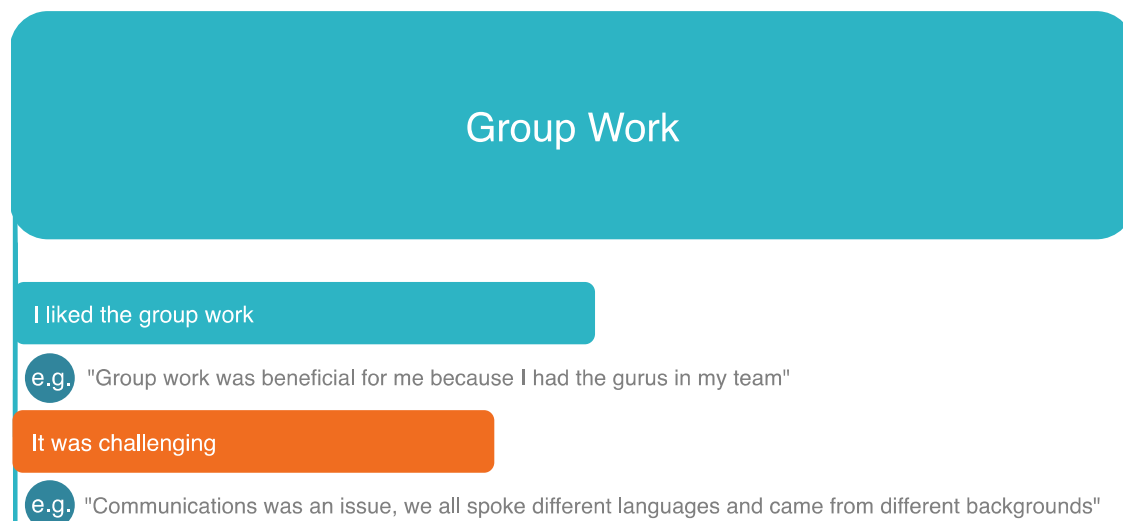


Figure 33: Participant comments and feedback with regards to the group work component of the training-course.

There is a rich amount of literature pertaining to the various merits, disadvantages, and ways to optimise group work (see Davies, 2009, Ackermann and Plummer, 1994, Brooks, 2006). Importantly, working in groups can bring out power imbalances, as highlighted by Cohen and Mullender (2002) among many others. It is therefore necessary, when organising participants into groups, to be cognisant of potential power imbalances, which may make group work a disabling learning activity for some. Davies (2009) recommend that course designers be cognisant of what they wish to achieve by including group work in the schedule of activities. If the function is to provide students with support while learning, then the time

allocated for group-activities needs to be substantial enough to allow for socialising and team solidarity. Davies (2009) also recommends that group sizes do not exceed four persons and that groups be allocated as early on as possible such that a sense of collegiality and common purpose might be fostered from early on (Davies, 2009).

Mixed methods and cross-cutting content

A popular point mentioned by the interviewed participants was the use of mixed methods during the training-course. Those who mentioned mixed method training were impressed with the variety of methods used to communicate and teach during the training-course. Participants explained that the variety of methods kept interest levels up, and allowed them to think about the same concept from different perspectives. Participants also mentioned that it was especially helpful when one type of method of communication was embedded in another (e.g. short videos embedded in a PowerPoint™ presentation). Interviewees also mentioned that using the same content across different sessions, and explaining the same content using different methods helped them understand more complex concepts. Therefore repetition and linking of content across different sessions was mentioned as a way in which the course designers enabled participants to understand the content.

A few participants expressed the need for a fieldtrip, in order for them to be able to see how the concepts they were learning about played out in the real world. Unfortunately neither of the training-courses had a fieldtrip, and the participants noted this as a disappointment. Many participants enjoyed hearing about real-world examples, and praised one facilitator in particular who used a number of real-world examples in her presentation.

5.2.2 Learnings from the Climate System Analysis Group training-courses

Through process observation, anonymous feedback, and semi-structured interviews, three dominant themes were identified in terms of the positive experience participants had learning, namely: collaborative learning, keeping interest levels up, and careful content framing. These three themes are considered important areas to strengthen and build on in future.

Collaborative Learning

Discussions from the interviews suggest that collaborative learning was an important enabler in encouraging participants to engage in the various learning activities offered at the training-courses. The sections below discuss aspects of collaboration mentioned in the interviews, in more detail.

i) Participant Group Diversity

A theme that emerged quite prominently during the interviews revolved around social interaction and the diversity of the participants and lecturers. Participants stated that they enjoyed learning from their fellow participants, particularly since there was generally a great deal of variety in terms of participant country of origin, background, and discipline. This allowed participants to view concepts and problems from a different perspective, which often resulted in better understanding.

Whitton and Moseley (2012) argue that working collaboratively allows students to work to their strengths while learning from those who are more able in particular areas. Similarly, participants enjoyed learning from their fellow participants, since there was generally a great deal of variety in terms of participant country of origin, background, and discipline. Participants also mentioned that they appreciated the opportunity to network and collaborate with other participants. The experience of attending a training-course over a few days ignited a sense of camaraderie within the group, which allowed for more fun to be had. Participants mentioned that it made a huge difference to be in a space physically (not necessarily in the same room, but face-to-face with other learners and lecturers) in terms of their ability to take information in and learn in a group of other learners.

Attending the training-course encouraged participants from all of their diverse fields to focus their attention on the over-arching issue of climate change, and how the effects of changing weather patterns and global temperatures might impact all of their sectors. Therefore, the training-courses were able to expose participants issues relating to science and practice that may not usually be addressed in their every-day work life.

Individuals who work in policy and academia found that it was good for some of the participants to talk to practitioners, and hear how they experience problems and deal with them on the ground. This means that course convenors need to be selective in whom they choose to attend the course, and try to maximise diversity of participants while still keeping with relevant backgrounds. The more diverse the group, the more they can learn from each other just by attending the course. Interviewee responses revealed that participants would have liked more opportunity to network and talk amongst each other. Many interviewees stated that having different people from different backgrounds at the training-course allowed them to learn from each other's experiences.

Participants felt that, since climate change affects all disciplines, it is necessary to tackle the problem using a cross-disciplinary approach. Attending the training-course and discussing the issue with participants from disciplines and sectors different to their own participants were able to get a taste of what it would be like to work in a team that consisted of people from different disciplines, with different expertise. Most of the participants enjoyed working in multi-disciplinary teams.

Having a mix of participants from a variety of backgrounds was highlighted as a component of the training-course that genuinely added value to the learning experience. A minority of participants felt that the different languages spoken by different participants were a barrier to learning, especially when participants were conducting group work activities. Perhaps this issue could be improved on if experienced group facilitators provided groups with the necessary tools for better group work.

ii) ["We're in this together"](#)

Although many of the participants felt that the training-course content was daunting, there was also a sense of camaraderie amongst participants. A few participants mentioned that doing the pre-training-course questionnaire encouraged the sense of, "everyone is in this together, and no-one is going to be treated differently", given that everyone was asked to do the questionnaire, no matter their perceived rank. The opportunities for socialising and joking, the laughter and enjoyment that was activated through game playing, all added to

the camaraderie within the group. This, in turn, enabled more positive networking opportunities, and perhaps longer-lasting connections. The sense of camaraderie also made participants feel more comfortable in the setting, with each other. One participant in particular noted that it was easier to understand and concentrate on the lectures when she had gotten to know the rest of the group. She felt more relaxed in her environment once she knew who she was sitting next to, and was able to participate and engage in more meaningful ways:

“The lectures were nice for learning because it was relaxed and casual. I don’t like formal teaching, it makes people nervous.”

Unfortunately, the scope of this study was not able to include data collection a few months after the training-courses took place in order to investigate the long-term impacts of attending such a training-course.

Keeping interest levels high

An assumption is sometimes made during capacity building training-courses that since participants are attending a training-course; they must be interested in the topic being taught. However, interview discussions revealed that although participants are attending training to learn, they need to be persuaded that this is a topic that is interesting and worth their time and concentration. The sections below discuss the importance of keeping participants interested and motivated in training-courses.

i) Using a mixed methods approach to training

The variety of methods kept interest levels up among study participants, and allowed them to think of the same concept from different perspectives. Nerlich et al. (2010) have previously suggested a mix of communication methods and strategies be used to communicate climate change issues, ranging from verbal to visual, from the spoken word to digital messages. The real challenge is to find ways to communicate that are creative such that they engage both analytic and experiential learning systems (Marx et al., 2007). One way of doing this is through active engagement.

“I liked that the exercises linked back to the lectures work well in combination.”

ii) Active engagement

Interacting with and engaging the participants in two-way learning is important. They are not school children or undergraduates, and therefore should not be treated as such. It is important for lecturers to engage with their opinions. The lectures should not be formal, but rather more relaxed, less like traditional teaching and more like active discussion.

Some participants had never been accustomed to teaching and learning using games, and seemed to only take the formal lectures seriously. Many participants enjoyed the games and gained a better understanding of content being taught by playing the games. However, a few other participants did not understand the relevance of the games and would have appreciated if the time had been spent on traditional lecturing activities.

“The games were childish and annoying.”

iii) Applicability of training course content

A strong theme that emerged has to do with the applicability, and usability of what was learnt, at the training-course. It is clear that participants wanted to take home more than just information on climate change and adaptation. It was extremely important to learn tools, to learn exercises that could be applied and repeated in their respective workplaces, to learn teaching methods, and to create networks and connections with the other participants, as well as the training-course organisers and lecturers themselves. Participants did not just come to the training-course to learn the content of the program.

“I like that I can use the exercises in my job.”

and

“Group work and exercises help with the application and realisation of how we can apply the information in real life.”

iv) The wide scope of the training course

Participants appreciated the diverse range of topics that were taught. A fine balance is needed between a wide range of topics, to keep interests up and to be relevant to as many people as possible – but also not to make the scope too broad such that the key message is lost and the audience feels overwhelmed.

One of the reasons participants found such value in the training-course was because of the diverse range of topics provided them with basic understandings of climate change and adaptation. None of them walked away experts, but many of them walked away having become accustomed to the jargon, the buzzwords, the acronyms, and the important definitions that surround the issue of climate change and adaptation. They have a basic understanding, and should they wish to engage on a deeper level, they now know what to look for and where, and importantly where to practice caution.

Even when lecture content was not explained clearly, or the participant found the content too complex to understand, participants reported that they always found some value in every lecture. Some of the participants valued just being at the training-courses, and were grateful for any information they were able to learn. What is clear is that different people have different appetites for learning.

[Framing: a fine line between confidence building and hopelessness](#)

There was a deep realisation among participants that the issue of climate change was bigger than they had initially thought. Some mentioned that the training-course had been a huge eye-opener for them in terms of the complexity, reality, and scale of climate change. Some had come to the training-course believing that they knew all there was to know about climate change, but left feeling as though they still have a lot to learn in this regard. Many participants felt that the training-course had been a big eye-opener for them in terms of the, **complexity, reality, and scale** of climate change. A few participants admitted that they had come to the training-course believing that they knew all there was to know about climate change, but left feeling as though they still have a lot to learn in this regard. The implication of this is varied. Participants may leave the training-course feeling motivated to

learn more and read up on the topic on their own accord, or they may leave feeling like the topic is too enormously complex to engage in. This is where appropriate content framing becomes extremely important.

i) **Hopelessness**

Some of the participants felt a sense of hopelessness, especially in terms of coming up with an adaptation strategy, and suggested that the feeling was triggered by an information overload. Pidgeon and Fischhoff (2011) argue that depending on how climate change information is communicated; it can fuel both disbelief as well as fatalistic acceptance of climate related changes.

“Given the uncertainties on climate science, too much information left me feeling hopeless.”

and

“Developing a adaptation strategy feels daunting if not impossible, perhaps too much information.”

and

“I don’t like putting uncertainty into documents - it looks weak.”

Interestingly, 10 participants completed the course feeling less positive about climate change issues than they did to begin with. Pidgeon and Fischhoff (2011) argue that depending on how climate change information is communicated; it can fuel both disbelief as well as fatalistic acceptance of climate related changes. Two to three participants seemed to suffer from an information overload. During the interviews, a few participants mentioned that they feel like it is impossible for them to act appropriately in terms of implementing adaptation strategies, since there are so many areas of uncertainty, and so many risks. Although the course convenors planned the course to include complexity and uncertainty, it is possible that the message of uncertainty came across too strongly for participants who had not heard of the uncertainties and complexities to be considered prior to attending the course.

ii) Confidence building

Some achieved a confidence to ask questions relating to climate change. If the training has an effect such that a trainee feels confident in his or her ability to perform in a certain way, they are more likely to transfer such knowledge and/or skill to the job (Velada et al., 2007). Interestingly, one of the participants who described himself as a villager from a small village in the Northern Cape of South Africa stated that after attending the training-course, he now felt more confident to ask questions about climate change:

“I had a small understanding of climate change before this, now I am going to be the village expert.”

This interviewee also proclaimed that he would now be a champion of climate change within his village. Although he stated that he felt very intimidated attending the training-course, since he was a leader in the village but not a scientist, or as he called it a “climate change guru”, he felt that attending the training-course provided him with a new confidence to talk about the issue within his community. This participant might have gained confidence for a number of reasons, from the interview with him, it was clear that he valued the opportunity of being in a full week training-course with experts in a field that was quite new to him. This participant’s experience is a good example of what capacity building training-course can achieve, since this participant in particular might return back to his workplace and feel confident to apply what he has learnt about climate change and adaptation in his everyday workplace. Velada et al. (2007) concur with this in their research, and argue that if training has an effect such that a trainee feels confident in his or her ability to perform in a certain way, they are more likely to transfer such knowledge and/or skill to the job.

6. Conclusion

This thesis explored the effects of climate change and adaptation training-courses on participant knowledge and perceptions of, and attitudes towards, climate change and adaptation and the relationship between these three variables. It also identified some merits and disadvantages of training methods and course design used at two climate change and adaptation training-courses.

The first and second objectives of the study aimed to determine whether or not attending a climate change training-course results in improved knowledge, and changes in participant perceptions of and attitudes towards climate change and related issues, respectively. In terms of knowledge changes, a majority of participants (68%) showed an increase in their knowledge scores after attending training. Similarly, 62% of participants responded more positively to the perceptions and attitude questions relating to CCA in the post-training test, compared to their pre-test responses. Although quantitative results show that the majority of participants knowledge scores increased after attending training, and that positive changes were observed in perception and attitude scores, the magnitude of these changes were small, and this may point to the idea that the training may not have a large effect on workplace decision-making in the medium to long term. The question of the longer-term effect on training is one that requires further research.

The third objective of this study was to determine whether a relationship exists between knowledge of climate change, and participant's perceptions and attitudes towards climate change and related issues. This research did not find a strong correlation between changes in knowledge, and changes in perceptions and attitudes; however, there were positive changes in all three variables. The findings on the relationship between knowledge, perceptions and attitudes are aligned with literature from existing behavioural and cognitive psychology. That is, an increase in knowledge can influence a person's perceptions of, and attitudes towards, an issue, but this influence does not always occur. In the case of this research, a very low correlation between knowledge change and perceptions and attitudes was found. However, this thesis was able to demonstrate how theory from cognitive and

behavioural psychology can support progress in communicating CCA information, when applied to the field of climate change and adaptation capacity building.

The fourth and final objective of this study was to investigate methods of communication and training that are most effective in enabling participants to understand climate change information. Participants discussed six methods of teaching and training which enabled their understanding of CCA and related issues; namely, PowerPoint™ presentations, group work, practical exercises, games and role-play. Learnings from studying the training-courses highlight the importance of collaborative learning, diversity in participant groups, active engagement of participants with various mixed training methods and careful framing of content such that it inspires a sense of confidence rather than hopelessness. In terms of training methods and elements of course design, the merits and disadvantages of different training methods used at climate change and adaptation training-course are well aligned with current popular methods of teaching from the field of education and training.

A key finding to come out of this research is the understanding that different methods of communication and teaching affect people differently. There is certainly no on-size-fits-all solution to training mid-career professionals, and training-courses need to be tailored to the individuals participating in the course as much as possible. Further research could interrogate this finding much more deeply, potentially by exploring the relationship between different teaching methods and other variables such as a person's values, beliefs, personality, level education and/or cultural background.

CSAG’s climate change and adaptation training-courses are designed such that they are broadly in line with recommended learning optimization techniques. However, there are some areas where improvements could be made to optimize the learning experience of participants (Figure 34 provides a summary of CSAG’s training-course strengths and weaknesses).

Training Strengths

Elements of course design which enable learning and participant engagement:

Networking and Opportunities for Discussion:

Facilitated discussion sessions and networking opportunities keep participants interested in the topic, and enable participants and lecturers to share knowledge and context specific experiences. This also increases the potential of fellow participants to work together post-training.

The power of popular people:

Distinguished lecturers keep interest levels up and thereby help participants concentrate on what is being said.

A combination of methods:

Presentations with embedded visuals, sound and video clips and sessions which use a mix of presentation methods i.e. lectures with games.

Playing games and having serious fun:

The use of games and role-play to communicate complex concepts and increase energy levels in the room.

Diversity amongst lecturers and participants:

Learning from each other and approaching problems and considering solutions from a variety of different perspectives.

Training Weaknesses

Elements of course design which are counter-productive to maximizing participant learning experience:

Poor content framing:

Content needs to be framed such that participants feel confident to engage in the topic of CCA, and not a sense of hopelessness.

Too few examples:

Real examples of successful climate change adaptation tends to inspire confidence. A focus on complexity/ uncertainty (however important) can be counter-productive to training.

Unknown participant needs:

In order to maximize learning and participant engagement, the programme content needs to be curated to suit the training-course participants in terms of the topics covered, the level at which the content is pitched, and the speed at which it is taught.

Unclear training outcomes:

Participants need to know exactly what they will get out of training, specifically which tools and skills they will gain by attending training-course.

Poor facilitation:

Discussions, games and group-work need to be well-facilitated to maximize the positive effects thereof.

Future Research

- Identify which of the above identified strengths and weaknesses influence participant perceptions and attitudes and which influence knowledge uptake.
- Explore the effect of content framing on participant knowledge, perceptions, and attitudes.
- Measure changes in participant knowledge, perceptions, and attitudes 6 months post-training.
- Identify whether or not participants are able to use the knowledge and skills learnt at the training-course in their workplace.
- Identify what sort of knowledge and skills participants need to make more informed decisions and climate change and adaptation, and focus content on those areas.

Figure 34: Key research contributions to the field of climate change and adaptation communication and training.

One of the motivations to explore methods of communication and training in the field of climate change and adaptation grew from a literature review of the effectiveness of different climate communication strategies, by authors Wolf and Moser (2011). In their paper, Wolf and Moser (2011) identified the need for more in-depth studies focused on understanding how different conditions enable or disable the learning process when it comes to teaching and communicating content relating to climate change. Peer-reviewed literature on the evaluation of climate change training-courses as a capacity building strategy in particular, is severely lacking - not only in the context of South Africa but on a global scale.

This is problematic, since training-courses and workshops are regularly used as a tool to convey CCA information to individuals who work in government and other important stakeholders, since these individuals can play a key role in reducing the negative impacts of climate change. Climate change and adaptation training and communication efforts has largely ignored lessons learnt from cognitive and behavioural psychology, as well as from the fields of education and training. Furthermore, climate scientists who are trying to build capacity through training-courses need to recognize that PowerPoint presentations alone are no longer enough to keep audiences engaged and interested. Given the potential for individuals in positions of decision-making to reduce the negative impacts of climate change, it is more important than ever before that scientists be more effective in the ways in which they communicate what they know to those who have the power to influence.

This research project has been explorative in nature, looking at the effect of climate change training-courses, and ways in which one might optimize such courses by improving methods of communication and training. The scope of this thesis was purposefully broad. Future studies relating to this one might consider studying each of the four research objectives separately.

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List of Appendices

Appendix A: Training-Course Programmes (Winter School followed by ASSAR)

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Appendix A: Training-Course Programmes (Winter School followed by ASSAR)

Winter School 2015 Programme					
	Monday 13 th July	Tuesday 14 th July	Wednesday 15 th July	Thursday 16 th July	Friday 17 th July
AM session (9:00 – 12:30 with tea break)	Welcome (RW) Pre-course Evaluation (CvW) (45min) Introductions, expectations, objectives (15min)(RW) Understanding the climate system and system feedbacks (2.5hr) (CL)	Climate baseline – intro to CIP (PK)(1hr) Using Observation data hands-on (<i>Case study facilitators</i>) (2hr) The decision making pathway (1hr)(AS)	Multi-lines of evidence (climate & social) (CJ) Modelling & Downscaling (PW) Grill session 2	Exploring climate scenarios hands-on (<i>Case study facilitators</i>) Climate Risk Ranking (AS & KW)	Guest presentation - TBC Finish Case studies work Presentations: Case Study 1 Case Study 2 Case Study 3
LUNCH		Development and Mitigation (MB)	Communicating Science (LJ)	Ethics and Conflicts in climate change (BH)	
PM session (13:30 – 17:00 with tea break)	Grill session 1 (CL) (30min) Common skeptics answered (30min) (CL) Intro to VULA (30min)(KS) Landscape of climate info & intro to climate services and portals (45min)(KS) Introducing to the case studies (30min)(KS)	Social/climate vulnerability and vulnerability assessments (KW & AS) : Vulnerability exercise (AS & KW)	Concepts of uncertainty (1hr) (TH) Risk Game (RB TH & PK)(1hr) Exploring climate scenarios hands-on (<i>Case study facilitators</i>)	Climate adaptation options (AS & KW) Case studies work	Presentations: Case study 4 Case study 5 Post - course Evaluation (CvW) Wrap up, closing (RW)

ASSAR TRAINING COURSE: WEEK 1			
Understanding climate information and adaptation in the context of semi-arid regions			
	Wednesday 26th August	Thursday 27th August	Friday 28th August
Morning 9:00–12:30 with tea break	Welcome (MN + MZ) & Setting the scene: Expectations and objectives (KS + CvW) ±1hr 45mins	Understanding the climate system - Part 1: Global (with particular focus on semi-arid regions) (CL) ±1hr 30mins	Multi-lines of evidence (climate & social) (CJ) ±1hr 30mins
	Introduction to case studies per region (1 participant per region) ±15' per region (10' to present, 5' for questions)	Understanding The Climate System - Part 2: Regional Messages (to be confirmed, 1 per region) ±15' per region (10' to present, 5' for questions)	Modelling & Downscaling methods (CL) ±1hr 30mins
Lunch Break			
Afternoon 13:30-17:00 with tea break	Introduction to case studies per region continued (1 participant per region) ±15' per region (10' to present, 5' for questions)	Understanding the climate system (cont.) - Part 2: regional messages (to be confirmed, 1 per region) ±15' per region (10' to present, 5' for questions)	Human Responses and Well- Being: Exploring the ASSAR Framework (GZ + IZ) ±1hr 30mins
	Introduction to decision-making with climate change information (including game) (CJ / AS) ±45mins	Landscape of climate information & introduction to climate services and portals (KS) ±45mins	Interactive discussion, reflection and feedback session (BK) ±1hr
	Speed networking (KS + BK) ±45mins	Climate Portal Efficacies (including discussion) (CJ/KLW/KS/TK) ±1hr	

ASSAR TRAINING COURSE: WEEK 2					
Understanding climate information and adaptation in the context of semi-arid regions					
	Monday 31st August	Tuesday 1st September	Wednesday 2nd September	Thursday 3rd September	Friday 4th September
Morning 9:00– 12:30 with tea break	Monday warm- up (BK/KS) ±30mins	Concepts of uncertainty (TH) ±1hr 30mins	Exploring future climate projections of portals: Hands- on session (KS + PLK) ±2hrs	Climate Adaptation options appraisal (KLW + AS) ±1hr	Group work wrap up: Case study/ regional workplan and development of communities of practice (including M&E) (LS, MZ) ±1hr 30mins
	Introduction to portals of use for the workshop (KS + PLK) ±30mins	Communicating uncertainty (including discussion) (BH) ±1hr 30mins	Risk Game (RB + ASH + PLK) ±1hr 15mins	Decision making on a national /provincial level (BK + GZ) ±1hr 30mins	
	Using Observation data hands-on (KS + PLK) ±1hr				
Lunch Break					
Afternoon 13:30- 17:00 with tea break	Vulnerability and adaptation discussion from an ASSAR perspective (BK) ±1hr 30mins	Ethics and Conflicts in climate change (BH) ±1hr 30mins	Assessing complex risks and adaptation options (Part 1) (BK) ±1hr 30mins	Climate and Agriculture (PJ + NM) ±1hr 30mins	Course evaluation/ post- intervention questionnaire, wrap up, closing (KS + CvW) ±1hr 20mins
	Vulnerability Assessment Tools (BK) ±1hr	Exploring uncertainty and ethics (interactive session) (BK + LS + MN) ±1hr	Assessing complex risks and adaptation options (Part 2) (BK) ±1hr 30mins	Interactive questions session (World Café style) (All facilitators) ±1hr	

Appendix B: Perceptions and Attitude Questions with Likert Scale

Question	Scale
Reduction of greenhouse gas emissions is the primary way in which government should approach the issue of a changing climate, in order to reduce the negative consequences thereof.	Strongly agree = 1 Agree = 2 Disagree = 4 Strong disagree = 5 I don't know = 0
With regard to my job responsibilities, activities, and key performance areas, I can think of changes that I could make that would result in a reduction of greenhouse gas emissions.	Strongly agree = 5 Agree = 4 Disagree = 2 Strong disagree = 1 I don't know = 0
I think that governments need to prioritize adaptation more than they are currently doing, even though this may mean allocating more government resources to the issue.	Strongly agree = 5 Agree = 4 Disagree = 2 Strong disagree = 1 I don't know = 0
I feel a very strong sense of responsibility to highlight and/or address issues that relate to climate change in my workplace.	Strongly agree = 5 Agree = 4 Disagree = 2 Strong disagree = 1 I don't know = 0
How would you rate your current understanding of the science that supports climate change?	Not at all informed = 1 Not very well informed = 2 Fairly well informed = 4 Very well informed = 5 I don't know = 0
It is expected that I apply knowledge of climate change when making decisions at work.	Strongly agree = 5 Agree = 4 Disagree = 2 Strong disagree = 1 I don't know = 0
Given the uncertainty around the potential impacts of climate change, I feel that other issues like lack of food and clean drinking water, and the spread of infectious diseases should be prioritized.	Strongly agree = 1 Agree = 2 Disagree = 4 Strong disagree = 5 I don't know = 0
It is now more important to focus on climate change adaptation rather than on reducing greenhouse gas emissions.	Strongly agree = 5 Agree = 4 Disagree = 2 Strong disagree = 1 I don't know = 0 Other = 0
Climate models are too uncertain to be used as a tool for prediction and planning.	Strongly agree = 1 Agree = 2 Disagree = 4

	<p>Strong disagree = 5 I don't know = 0</p>
<p>When it comes to climate change issues, I feel there is too much pressure on me to include the issue in my job.</p>	<p>Strongly agree = 1 Agree = 2 Disagree = 4 Strong disagree = 5 I don't know = 0</p>
<p>I don't see how I can apply knowledge of climate change in my workplace; the information is interesting but not relevant to my job</p>	<p>Strongly agree = 1 Agree = 2 Disagree = 4 Strong disagree = 5 I don't know = 0</p>
<p>Climate Change information is interesting, but it is too complex to apply to the everyday workplace.</p>	<p>Strongly agree = 1 Agree = 2 Disagree = 4 Strong disagree = 5 I don't know = 0</p>
<p>I would like to include climate change issues more in my work.</p>	<p>Strongly agree = 5 Agree = 4 Disagree = 2 Strong disagree = 1 I don't know = 0</p>

Appendix C: Knowledge Questions

Please indicate whether you agree or disagree with the following statements, in reference to Figure 1 (below). Answer options: Agree, Disagree, I don't know.

Correct Answers are displayed in blue.

Figure 1 shows the month that receives the most rainfall, on average, in Cape Point

Figure 1 shows averaged maximum and minimum temperatures in January at Cape Point

Figure 1 shows daily maximum and minimum temperatures in December at Cape Point

Figure 1 shows the average minimum temperatures in Stellenbosch during the wet season

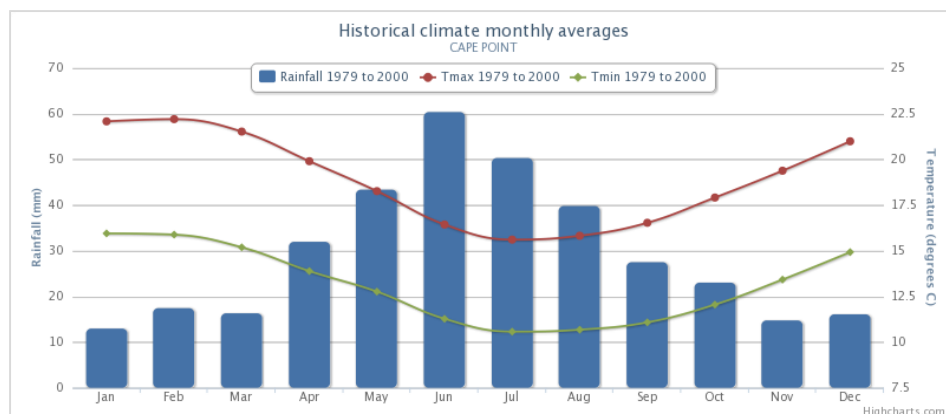


Figure 1: Cape Point - Historical Climate Monthly Averages

Please tick the information you think you could obtain from Figure 2 (below):

Current total monthly rainfall in South Africa.

Drought warnings for next year's rainy season.

Flood warnings for next 5 year's rainy season.

The projected total monthly rainfall anomalies for the next year.

Current percentage wet days per month at Cape Point.

The projected total monthly rainfall anomalies for 2040-2060.

The projected total monthly rainfall anomalies for the 2050's.

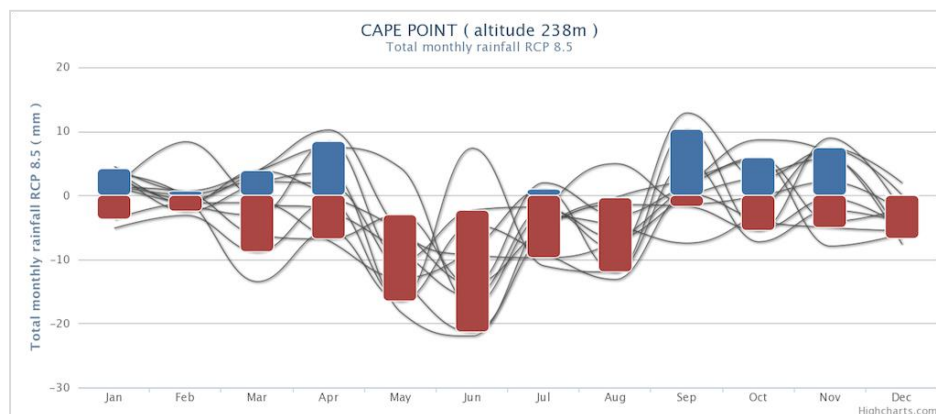


Figure 2: Cape Point - Projected Total Monthly Rainfall for the Period 2040-2060

#	TRUE AND FALSE	ANSWER
1	Mitigation of greenhouse gases is about reducing the amount of carbon dioxide and other specific gas emissions in the atmosphere.	TRUE
2	Climate is average weather.	TRUE
3	Climate model projections are accurate because they are able to explore and quantify all sources of uncertainty.	FALSE
4	Climate change is defined as any change in climate over time, whether due to natural variability or as a result of human activity.	TRUE
5	Adaptation to climate change is about reducing the impact of climate events.	TRUE
6	Climate change is now unavoidable, and will be long lasting.	TRUE
7	Probabilities in climate models reflect the level of uncertainty that climate scientists have as to whether climate change is happening.	FALSE
8	Differential heating of the globe results in energy transfer which together with the spin of the earth and position of the continents gives rise to our weather systems as we know them.	TRUE
9	Climate models only include the processes that are very well understood.	FALSE
10	A certain amount of global warming is now unavoidable, due to gases that are already present in soils.	FALSE
11	Decision-making on the basis of historic climate is robust.	FALSE

Appendix D: AN example of a completed “Climate Change Impacts, Risk and Vulnerability ranking” exercise.

Key sectors and activities	Key climatic events in Bergrivier			
	High temp	Flood	Erratic rainfall	Heavy winds
Infrastructure - Roads	L	M	L	L
Infrastructure -Structures / buildings	M	L	L	M
Infrastructure - Low income housing	M	H	L	M
Infrastructure - Storm water	L	H	H	M
Service delivery - Water	M	M	L	L
Service delivery - Electricity	M	M	L	M
Natural Resources - veld / soil / land	H	M	M	L
Natural Resources - water quality / quantity	M	M	M	L
Residents' health	L	M	L	M
Seasonal work (employment)	M	M	L	L
Agric - wheat	M	L	H	M
Agric - potato	M	M	M	M
Agric - table grapes & wine grapes	M	L	M	L

Agric - fruit (bo-berge)	M	L	L	M
Fishing	M	L	L	H
Tourism	M	L	L	L
Manufacture & trade	M	L	L	L