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Teaching climate change: understanding the intellectual and emotional challenges

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Abstract

Introduction and Aims

This study aims to evaluate the relationships between emotions and learning in the context of climate change, a ‘wicked’ subject that has profound and worrying implications for the future. It explores barriers to engagement and the possible emotional obstacles to deep learning. as climate change is both a multi-disciplinary and troublesome subject. The relationship between knowledge, emotion and positive action is explored. The literature on effective teaching of complex subjects is also examined and how lessons from this can be applied to teaching climate change.

Materials and Methods

A questionnaire was designed with the aim of exploring students’ knowledge about and emotions towards climate change and their subsequent change in action after climate change teaching. A total of 207 (life science and sociology) students took part with 69 life science students completing the pre-learning and the post learning questionnaires. A focus group with three first year students and four in-depth interviews were also conducted.

Summary of Results

The results for the main quantitative phase showed an overall increase of concern and emotional awareness from the pre-to the post stages. An overall score for each respondent for knowledge and for emotion was calculated showing a weak correlation between the increase of knowledge and an increase in expressed concern. There were differences between course type and gender in terms of knowledge and qualitative findings show that although there are emotional problems when teaching climate change this should not prevent students learning but emotional resilience should be taught in tandem.

1.0 Introduction

1.1 Background

Anthropogenic climate change is a relatively new subject in higher education and draws on a wide range of other disciplines. Despite the international scientific consensus that anthropogenic climate change is real it remains a highly contentious subject, with vigorous and often distorted and inaccurate debate in the media and numerous high profile political and cultural figures disputing the basic facts, the scientific models and some of the likely implications. This thesis looks at the relationship between emotion and learning in the context of climate change and considers whether this relationship prevents or enhances learning and any subsequent environmental behaviour change. It looks for general lessons on how emotional responses affect learning and how these can be transferred to wider teaching

1.2 Personal standpoint

Climate change is a scientific subject. However, it is also political and emotional – hence the rationale for this thesis. This mix makes disinterested analysis – at least of the sociological and political dimensions - difficult or impossible. Hence it seems appropriate to give some personal information about me (the author), in a way that does not usually happen in scientific theses. I have a background in science but have also worked in social research for over fifteen years. I have been engaged in climate change activism for over 20 years. Hence, I bring a personal perspective that climate change is an urgent problem requiring immediate social change. I recognise that this personal perspective may influence how I interpret some of my research findings. I believe that the best way to avoid such personal bias is to be explicit with myself and my co-researchers about our personal perspectives, and then diligent in self-scrutiny in avoiding the influence of such bias. I have endeavoured to do this throughout this piece of work however I have not avoided drawing explicitly political conclusions where this seemed appropriate.

2.0 Aims and Objectives

2.1 Aims and Objectives

The study aims to evaluate what are the relationships between emotions and learning in the context of climate change. Climate change is a difficult subject that covers many disciplines that individually are complicated and challenging to comprehend and when put together can leave students bewildered and confused. Climate change also raises many emotionally charged and worrying issues for students to comprehend that will affect them and future generations and the study aimed to discover how teachers may acknowledge these and overcome any barriers to learning that they may present.

This study also aims to explore the self-reported levels of understanding, knowledge and emotion that first year students had around climate change prior to them receiving any climate change instruction or teaching and to then measure the change in self-reported level of understanding, knowledge and emotion. The research further explored the anticipated level of action around climate change that students might take as a result of their learning as very often students although aware of the issues around climate change do not change their behaviour (Lurtzman, 2011).

The study also aimed to explore the possible influences of disciplinary background on self-reported understanding, knowledge and emotions surrounding climate change and thus explored differences between students studying Sociology and Biology courses. This was explored as it was felt that biologists would be more aware and knowledgeable about climate change as it directly affected what they were studying.

Finally, the study aimed to look at gender and to see if there were any differences in reported emotion, knowledge and action between males and females as there are clear differences (Kollmuss and Agyeman, 2002; McCright, 2010).

Therefore the aims are to:-

- Explore the knowledge, understanding and emotion of students around climate change
- Examine the differences of knowledge, understanding and emotion differences between students who study social sciences compared to biologists
- To compare the knowledge, understanding and emotions of students who have completed a questionnaire before attending a lecture on climate change and three weeks after they had the lecture
- To look at gender and explore any differences

2.2 Hypotheses

The key null hypotheses tested in this work were:-

H_1 'There is no increase in self-reported knowledge when asked about climate change after climate change lectures'

H_2 'Self-reported awareness or knowledge is not affected by gender'

H_3 'There is no relationship between gaining knowledge of climate change issues and changing emotional responses to the issue'

H_4 'The course of study chosen, biology or sociology, has no impact on the level of self-reported knowledge or awareness of climate change prior to an introductory climate change lecture'

3.0 Literature Review

3.1 Climate Change

Climate Change is defined by the UK Meteorological Office as ‘a large-scale, long-term shift in the planet's weather patterns or average temperatures (Met Office, 2015). The sun heats the earth’s atmosphere, oceans and land which makes life on earth possible. The incoming radiation can easily pass through the outer atmosphere to reach the Earth, but much of the long-wave radiation that is reflected back from Earth cannot escape. Exactly how much of the radiation escapes the atmosphere depends on the concentration of greenhouse gases (including carbon dioxide, methane and nitrous oxide) present (Costello *et al.*, 2011). The natural greenhouse effect is necessary as without it, the temperature of the surface of the Earth would be -18°C, instead of the actual value of about 15°C (Mann *et al.*, 2012). However anthropogenic emissions have significantly augmented natural effects. As the levels of CO_2 and other greenhouse gases are rapidly increasing – CO_2 has risen from 315 ppm in 1958 to its current level which is at 407.40ppm (2016 ProOxygen, 2016) - the overall temperature could increase by more than 4^{o}C without mitigation by the end of this century depending on the amount of CO_2 in the atmosphere (Revesz *et al.*, 2014). 2014 was the warmest year since records began in 1910 and since 2002 the UK has experienced eight of the top ten warmest years (Met Office, 2015a) with 2015 and 2016 predicted to be the warmest on record (Carrington, 2015).

The Intergovernmental Panel on Climate Change (IPCC) was set up to look at the science in 1988 and works under the United Nations. Thousands of scientists from all over the world contribute to the work of the IPCC on a voluntary basis. Peer review is an essential part of the IPCC process and ensures an objective and exhaustive assessment of current information.

The Fifth Assessment Report (AR5) came out in 2013 and states that *“warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have*

diminished, sea level has risen, and the concentrations of greenhouse gases have increased. (IPCC, 2013)*"*

3.2 Consensus Science and What will happen in the Future

The case for anthropogenic climate change has been well documented by various bodies. The latest report from the Intergovernmental Panel on Climate Change (IPCC) states that…

> *"Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. This evidence for human influence has grown since AR4 (*published in 2007*) It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.* (IPCC, 2013)*".*

Hence there is unequivocal evidence that global warming is already happening and regardless of any greenhouse gas reductions over the coming years the past and current usage levels of these gases means that climate change is unavoidable (The Scottish Government, 2014). In a UK government-commissioned review, Stern suggested in 2006 that there was a 75% chance that global temperatures would rise between 2-3^{o}C compared with pre-industrial levels in the next fifty years (Stern, 2006). Subsequent studies have tended to indicate even higher temperatures are likely; probably 4 - 5^{o}C in the long term average (Stewart and Elliott, 2013). 2014 has also been one of the warmest and wettest years since records began, and the warmest ever recorded year in Scotland (Met Office, 2014). Hence there is broad scientific consensus on the causes of anthropogenic climate change, (97% of climate change scientists concur with the views of the IPCC (Anderegg *et al.*, 2010; Lewandowsky, 2011; Cook *et al.*, 2013)) and on the need for urgent action in response to anthropogenic climate change.

There are many other voices now supporting this view including Pope Francis, who sent a papal encyclical to *'every living person on this planet'* highlighting that climate change is real, urgent and called for a discussion on how to tackle it using a bottom-up approach thus ensuring that all are included in the need for action (Pope Francis, 2015; Li *et al.*, 2016). Barak Obama, the US President, has also joined calls for action and is putting into place the Clean Power Plan which aims to reduce carbon dioxide emissions by 32 percent from 2005 levels by 2030 (EPA, 2015).

The 21st Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) took place in Paris between November 30th and December 12th, 2015. The Conference was historic in that 196 countries agreed to hold the increase in the global average temperature to well below 2°C above pre-industrial levels. Delegates also said they would pursue efforts to limit the overall rise in global temperature to 1.5°C. There were pledges to reduce countries' individual carbon emissions, a long-term goal of zero carbon emissions between 2050 and 2100 and anticipated reviews every five years to ensure that overall warming remains below 2°C with the first review being in 2018. There is intention to set-aside money for developing countries to help with the transition to clean energy. Hence COP21 resulted in impressive and important rhetorical support for an international response to climate change. However there is serious doubt from informed scientific opinion about the feasibility of these commitments (Anderson, 2015).

3.2 General Denial and the Psychological Mechanisms and Causes of Denial

There has been considerable research on the psychological concept of 'denial'; to what extent people can just 'stick their heads in the sand' or ignore 'the elephant in the room'? This section seeks to outline the different types of denial. Some research has considered very shocking, emotional experiences that are so awful they may overwhelm people's usual capacities to react. For example, Lifton's research with Hiroshima survivors found people unable to react rationally to the world (Lifton, 1971); he coined the term 'psychic numbing' to describe this. Slovic applied this term to survivors of mass genocide in various

countries including Ethiopia, Rwanda, the former Yugoslavia and Cambodia (Slovic, 2007).

Cohen (2001) talks about three types of denial when discussing atrocities and suffering: literal, interpretative and implicatory. Literal denial is self-explanatory in that it describes a refusal to acknowledge that something is true, for example, a father abuses his daughter and the mother is incapable of understanding that her husband can do something like that to their child, despite compelling evidence. Faced by large scale atrocities like the holocaust or Hiroshima people may react by saying that nothing happened or that they knew nothing about it and the term 'psychic numbing' has been used to describe this (Slovic, 2007; Lurtzman, 2011).

Interpretative denial occurs when a euphemism or distortion is used to change the meaning and import of what has happened; for example, I am a social drinker – not an alcoholic; it was not ethnic cleansing but a population movement.

The third type of denial discussed by Cohen is implicatory, in which an individual accepts the fact of an uncomfortable reality but denies any responsibility to do something about it; this could be starving children in Africa, massacres in Rwanda or East Timor or homeless people in the UK (Cohen, 2001; Norgaard, 2006). Distancing the situation by saying 'it's got nothing to do with me' or 'what can I do about it?' thus suggests that the person is aware of the problem and that something needs to be done about it but that they are unwilling or feel unable to do anything about it themselves (Slovic, 2007). In such cases the reasons for a failure to act in the face of disturbing information may be complicated and could reflect a genuine indifference but might also be a form of emotional distancing and denial. Therefore implicatory denial is directly linked to an unwillingness to take action as well as to negative feelings and is different in this respect from literal and interpretative denial (Norgaard, 2006; Weintrobe *et al.*, 2013)

Zerubavel ‘s discussion of denial uses the allegory of the ‘elephant in the room’ and how people pretend that it is not there (Zerubavel, 2006). Zerubavel discusses general denial that happens over time or because of changes in culture shifts such as same sex couples becoming acceptable rather than unusual or the semi-official decision adopted by the American Military to avoid discussing subjects such as sexual preference and instead using the ‘Don’t ask/ don’t tell’ (DADT) policy for gay men and women (Belkin and Embser-Herber, 2002).

Another type of denial involves a conscious decision to ignore the situation that you are in and to find ways of pretending that you are not in that situation, for example the sorts of deliberate thinking that might happen whilst having a pelvic or prostrate examination. The fourth type of denial is ‘taboo’ where society, mostly implicitly, prohibits looking, listening and speaking. Zerubavel cites the three monkeys - ‘see no evil, hear no evil, speak no evil’ - as a very good analogy; films including Mississippi Burning and A Few Good Men are based on the same theme of a very strong culture or code that a group of people need to adhere to (Zerubavel, 2006). Lastly, tact is used as a more subtle form of taboo as it is used instead of being perceived as being rude, such as pretending not to hear something that could be embarrassing (Cuc, Koppel and Hirst, 2007).

Operating at a different level from these psychological understandings of denial are the ways in which it is manufactured, enforced and manipulated for political ends. These might include deliberate distraction such as a government starting a war as a diversion from problems at home; the media is a key player here as they control what is published, how it is reported and how long items stay newsworthy (Carvalho and Burgess, 2005; Boykoff and Boykoff, 2007). This might also involve direct attempts to control thought, such as when people are told to mind their own business, like during WW2 when people who lived near concentration camps were told to look away or down so that they did not ask questions or feigned ignorance by not speaking or being curious. Similarly, secrecy and denial can be imposed by a mixture of authority and group loyalty,

usually bolstered by justificatory ideology, such as used by the Catholic Church during child abuse scandals (Zerubavel, 2006).

3.3 Climate Change Denial and the Rhetorical Tools used by Deniers

There are a range of dissonant voices in the climate change debate. These include those who believe that the rise in carbon levels is a good thing for the planet (for example because it might increase plant productivity) as well as those who attribute negative effects associated with climate change, such as soil erosion, flooding, famine, drought and species extinction, to other impacts such as habitat destruction and over-use of the planet (Bellamy & Barrett 2010). Many organisations and individuals actively campaign to refute the scientific evidence (Begley *et al.*, 2007; Monbiot, 2007) whilst biased and partial coverage in the media reporting on climate change has an important impact on how the public perceive the issue (Boykoff, 2007, 2016; Lyytimäki, 2015).

Examination of literature showed that in early 2015 two-thirds of American people believed that climate change was caused by human activity and that a tenth understood that nine-tenths of all scientists agreed on the causes (Boussalis and Coan, 2016). That a third of Americans do not agree on the causes of climate change is attributed to the misinformation from conservative Think Tanks and politicians, the fossil fuels industry and denial blogs (Dunlap and McCright, 2015).

The models of denial described by Zerubavel and Cohen are applicable to climate change (Diethelm and McKee, 2009; Washington and Cook, 2011), with organised deniers using the political approaches described by Zerubavel to help feed the psychological denial outlined by Cohen. As an example of the conscious spreading of doubt, ‘Climategate’, during which email accounts at the University of East Anglia were hacked into and published on the internet, resulted in an independent investigation. The inquiry concluded that there was nothing in the emails that affected the science of climate change. Nonetheless climate change deniers have claimed that it is the ‘worst scientific scandal of all time’ (Booker, 2009) and have used a sympathetic media to help spread doubt about the climate change consensus. The debate on Climategate continues as David Holland, a climate sceptic, has taken East Anglia University to an

information tribunal as he feels that they have not released all the information they should have done (Matthews, 2013). Regardless of the strength or weakness of the case this ensured that 'the conspiracy' remained current in the media.

Petition Project is an example of 'fake experts' (Diethelm and McKee, 2009) where anyone with a formal Bachelor of Science degree in an appropriate scientific field in the USA can sign an on-line petition. The website has a 12-page review of the literature which ends its arguments by saying that *"As coal, oil, and natural gas are used to feed and lift from poverty vast numbers of people across the globe, more CO_2 will be released into the atmosphere. This will help to maintain and improve the health, longevity, prosperity, and productivity of all people. The United States and other countries need to produce more energy, not less. …….. Mankind is moving the carbon in coal, oil, and natural gas from below ground to the atmosphere, where it is available for conversion into living things. We are living in an increasingly lush environment of plants and animals as a result of this CO_2 increase. Our children will therefore enjoy an Earth with far more plant and animal life than that with which we now are blessed."* (Robinson et al. 2007).

Other common tactics used to fuel climate change denial include:-

- Impossible expectations – being able to model or predict exactly what will happen in the future is impossible to do and this lack of perfect precision is often used as a reason for not believing the broad predictions of models (Hansen *et al.*, 2006).
- Misrepresentations and logical fallacies such as claims that climate has changed in the past so climate will change in the future and that current changes are just due to normal fluctuations (Lorenzoni, Nicholson-Cole and Whitmarsh, 2007).
- Cherry-picking or only focusing on narrow parts of the data or on a few unrepresentative papers that promote an argument but do not show the whole picture (Oreskes and Conway, 2011), some examples are:
    - Claims that global temperature measurements are unreliable

- Global warming stopped in 1998;a claim by Carter which has been disputed on numerous occasions (Hansen *et al.*, 2010)
- An article written by Macintyre and McKitrick (2005), who recalculated Michael Mann's famous 'hockey stick' data with the finding that the statistics were incorrect and that the test used would always produce a 'hockey stick effect' (McIntyre and McKitrick, 2005). The term 'hockey stick' came from a paper that showed the planet's temperatures going back half a millennium, the resulting graph resembled a hockey stick with the shaft showing a long period of minor temperature differences and the blade showing the sharp rise in temperatures during the Twentieth Century (Mann, Bradley and Hughes, 1998)

An example of cherry picking literature occurred when an 'important new scientific paper' entitled "Carbon dioxide production by benthic bacteria: the death of manmade global warming theory?" was published by the fake Journal of Climatic Studies from a fabricated Institute of Geoclimatic Studies based at Okinawa University. This deliberate and barely concealed hoax was then released on the internet and subsequently picked-up and circulated by some climate change deniers, revealing an enthusiasm for promoting their arguments without taking even simple steps to verify the source (Thorpe, 2007).

3.4 Climate Change Knowledge and Behaviour

Although knowledge does not automatically lead to a change in behaviour there are other predictors of behaviour despite knowledge such as self-interest and/ or concern for others. Self-interest is based on reducing health risks and concern includes other people, future generations, other species or eco-systems such as the oceans or animals or any of the results of climate change; rising sea levels, acidification of the oceans etc (Bamberg and Möser, 2007). There are many models or ways of defining environmental behaviour (Stern, 1992) and these are largely split into those that view environmental behaviour primarily as socially motivated versus those who view pro-environmental behaviour motivated by self-interest (Rhead, Elliot and Upham, 2015). Models based on socially motivated frameworks use the norm-activation framework

(NAM) (Schwartz, 1977) that looks at three main areas; awareness of consequences, acknowledgement of responsibility and personal norm. Which acknowledges that an individual is aware of the possible harm if not acting responsibly with pro-environmental behaviour and that their personal norm would therefore determine if they do so or not (Cordano *et al.*, 2010; Han, 2014). Models on self-interest often use more balanced starting points like the Theory of Planned Behaviour (Ajzen, 1991) from which to build their models and uses various factors such as attitudes, subjective norms, perceived behavioural control, behavioural intentions and behaviours (Passafaro *et al.*, 2014).

Although there is a gap between scientific knowledge and what the public think they know about science there is also a gap for those that are aware of the science but who choose not to do anything about it (Weintrobe *et al.*, 2013). Kollmuss and Agyeman (2002) felt that the reasons for public inaction included:-

- few opportunities for action for example, no public recycling schemes or no sympathetic party to vote for
- limited belief in their own ability to effect changes in their circumstances – a low internal locus of control and no links to people that share their sentiment
- the framework of the government policies does not encourage pro-environmental behaviour or makes it hard to access for example by providing public transport that is too expensive to use or not enough to make it worthwhile to switch
- they think it is too late to make a change or that key changes need to be made by others (Kollmuss and Agyeman, 2002)

Although some people are changing their behaviour there are others who choose not to change or cannot change their actions. There are barriers in place such institutional barriers, cultural barriers, physical barriers and economic barriers that prevent people from taking action (Swim *et al.*, 2009). Institutional barriers are common in the UK, USA and other developed countries and lack, for example, proactive flood management or poor communication between layers of government so that adaptation is inadequate (Wolf, 2011).

Cultural barriers are important ways of changing how climate change is viewed and moving away from talking about the science around climate change to becoming a social issue in much the way that people now perceive smoking and slavery (Hoffman, 2010; Menegaki, 2012).

Physical barriers to change include a lack of public transport to reduce car usage or limited local recycling centres (Semenza *et al.*, 2008). There are also personal barriers that limit change in behaviour and could answer why people agree that this is the right direction to take but are not taking that route and these take account of ignorance, both a lack of knowledge about climate change and what they can do about it. Uncertainty, mistrust of governments and scientists and not taking advice from them about what to do, denial (which is discussed in section 3.5), discounting the importance of climate change, how attached people are to the place they live or elsewhere, habit or how hard it is to change behaviour, for example, not jumping in the car but walking or talking public transport (Passafaro *et al.*, 2014).

There is also the perception that until climate change and the associated change in action and behaviour becomes something that everyone does and not just green groups or 'hippies' that there will not be much change. Social norms used in changing environmental behaviour is well researched and discussed (Lorenzoni, Nicholson-Cole and Whitmarsh, 2007; de Leeuw, Valois and Seixas, 2014; Passafaro *et al.*, 2014; van der Linden, 2015).

The relationships and gaps between knowledge, opinion and action are complicated but Lurtzman argues that these can be negotiated and that the subject matter is not too difficult to both comprehend and to deal with (Lertzman, 2014).

3.5 Why Denial Makes Learning Harder

A strong motivation for denial is fear. Many realistic climate change scenarios imply serious threats to future happiness and wellbeing. Faced with these prospects a common response is evasion or denial. There is also the notion that 2050 or 2100 is a long way in the future – maybe we can do something

nearer that time rather than now (Sterman and Sweeney, 2002). For example, in a Singaporean study it was found that 90% of young people are aware of environmental issues but do nothing about them; the impacts seem too far away in the future for them to take action (Chib *et al.*, 2009). Although there is also evidence that in countries or areas where climate change has made an impact such as in Haiti, Kenya, Philippines and India, children are very motived and vocal when discussing climate change and they should be consulted so that all policy is futureproofed (Unicef, 2013).

Predicted climate change impacts include oceans rising, ice caps and glaciers melting, mass migration, drought in large parts of the world and floods in others, increasing typhoons, hurricanes and storms and Amazon forest dieback. The latter is one prediction of climate models, when the combination of climate change, deforestation and the resulting fires degrade the Amazon rainforest which then dries and consequently dies with the increase in temperature (Schwartzman, Moutinho and Hamburg, 2012; Boulton, Good and Lenton, 2013; Morello, Floresta and Grosso, 2013).

The climate system is likely to exhibit tipping points, when the level of carbon dioxide reaches a critical level and one stable state switches to another stable state that is generally considered to be irreversible (Bellamy and Hulme, 2011). No one is quite sure when this will be, although it may already have been reached; some authorities believe 350ppm is the crucial level and CO_2 concentrations were already 385ppm in 2008 (Hansen, 2008) and are now just over the 400ppm mark (Simms, 2013; Scripps Institution of Oceanography, 2015). Extreme and catastrophic scenarios involving runaway climate change, where a runaway greenhouse effect could occur where the Earth becomes a planet like Venus (Russill and Nyssa, 2009; Tucker, 2012) are possible, all of which may leave the average person thoroughly confused and depressed and inclined to stick their head in the sand yet again. Given the overwhelming nature of the topic and the depressing nature of the facts, increased levels of information and/ or understanding of the subject could have a negative effect on concern and on a sense of personal responsibility (Kellstedt, Zahran and Vedlitz, 2008). There is some evidence that people stop paying attention to global climate change when they realise that there is no easy solution to it (Norgaard, 2006).

By the end of 2011 China was burning nearly as much coal as the rest of the world combined (3.8 billion tonnes compared to 4.3 billion tonnes from the rest of the world (Spross, 2013)), although their per capita CO_2 production (5.8 metric tons per capita as of 2009) is still lower than that of the United States or the UK (17.3 and 7.7 metric tons per capita, respectively (World Bank, 2013)). Countries that are 'catching up' economically with the 'first world' feel that they have the right to enjoy the commercial consumerism that the West enjoys and that they should not be stopped from doing so (Kuusi, 2012). In 2015 China was still the leading consumer of coal but the amount had reduced slightly (3.7 billion tonnes) while their renewable electricity produced went up from 17.3% to 24.7% over the same time frame (Enerdata, 2016). Given the initial irresistibility of this momentum, there was a real feeling of 'what's the point?' whereas now there is a trend that China is making changes to their policies and moving towards greener energy(Dai *et al.*, 2016).

It is worth noting that America and China have since signed a bilateral agreement on reducing greenhouse emissions and focusing on clean energy sources with America reducing greenhouse emissions by 26 – 28% below 2005 emissions and China reaching its peak emissions before 2030 (Hansen, 2014; Echeverría and Gass, 2015).

Geoengineering may also have a part to play in the lack of response from the average person. Speculative schemes involving engineering global climate by *"obstructing incoming sunlight by injecting reflective aerosols into the atmosphere, or launching screens into space to block a little of the Sun's light from reaching the earth"* (Dessler and Parson, 2010) may induce a resigned dependence on the power of technology to save us. Other ideas involve manipulating the global carbon cycle, for example by increasing ocean CO_2 uptake by fertilizing marine plankton with some limiting nutrient such as iron or directly removing CO_2 from the atmosphere. As conventional political approaches are increasingly seen to be failing, geoengineering could be a viable option in the future and may be the only way that CO_2 can be minimised or removed if the conventional methods are not used to their full potential. There are many political, legal and diplomatic problems with these solutions, for example, who has the right to put a big screen into space (Dessler and Parson, 2010), as well as social and ethical considerations such who will give

consent for the technology to be used, how it will be governed or policed and the possibility of conflict (Corner and Pidgeon, 2014). The key point about the future use of geoengineering to mitigate CO_2 is that this may be possible in the future but this must not be used as an excuse to avoid CO_2 mitigation now or in the future (Shepherd *et al.*, 2009). If geoengineering is used it should come with a big caveat and with the label 'moral hazard' (Hamilton, 2013a).

Public discussion of climate science and its implications has become highly politicised and partisan, particularly in the USA. Here a very vocal group called the American Legislative Exchange Council (ALEC) has been pushing through legislation, known as the Environmental Literacy Improvement Act, in various states including Texas, Louisiana and South Dakota. The focus of the bill is to mandate the teaching of climate change denial or scepticism as a credible alternative to anthropogenic climate change (Horn, 2012). The fundamentalist far right is a large, powerful constituency in the USA and Hamilton discusses how it is possible to guess what an American thinks about climate change by asking about their views on abortion, same-sex marriage and gun control. Overall, by associating accepting climate change science with having 'liberal' or 'left' views the American right has managed to disassociate themselves from entering the climate change debate on scientific grounds (McCright and Dunlap, 2011; Hamilton, 2013b).

One effect of inconsistent, poorly researched and biased media coverage (Ward, 2009) of climate change and its implications is that when students in higher education come to learn about the subject they may not engage with the material. Reasons given for the possible disengagement of students from studying climate change include: they are bored of repeated stories on the same subject; they feel that they are well informed and know all about the subject (but in fact may not); they have very emotional views both positive and negative on sustainability and climate change (Robinson, 2012). Lastly students may believe what the media says on the subject more so than scientific, peer reviewed information because of journalistic bias or possibly because media outlets have felt the need to provide a platform for climate change deniers in the

name of journalistic balance (Boykoff and Boykoff, 2007; Boykoff and Mansfield, 2008).

The Parliamentary Committee for Science and Technology has recently criticised the Government for not successfully communicating information about climate change to the public and not having a clear and consistent voice across departments.

> *'The Government's current approach to communicating conflates the scientific basis of climate change and the proposed solutions to its impacts and places a heavy reliance on individual scientists communicating about the science to justify the policy response. Efforts to create a clear narrative that is coherent, constructive and results in proper public engagement have been disappointing* (House of Commons Science and Technology Committee, 2014)*.'*

The report also talks about the role of the BBC and other media and says that….

> '*The main source of information for the public on science (including climate change) is news media, specifically the BBC. Media reporting thrives on the new or controversial. We heard that it was difficult to justify news time maintaining coverage of climate science where basic facts are established and the central story remains the same. Reporting on climate therefore rarely spends any time reflecting on the large areas of scientific agreement and easily becomes, instead, a political discussion on disputes over minutiae of the science or the policy response to possible impacts of climate* (House of Commons Science and Technology Committee, 2014)*'.*

The report is quite strong in its criticism of all areas of communication and says that the Government and other bodies such as the Met Office and the Royal Society are not engaging fully with the public and not using recent technology, social media etc. to communicate fully. There is also a view that while the media needs to stamp out denial it should also not allow climate catastrophists, who say that it is too late to do anything, so that a reasoned voice can be heard (Costello *et al.*, 2011)

3.6 Possible Next Steps or Solutions to Enable Learning

Everyone understands and perceives the risks associated with climate change in different ways, partly because of different individual outlooks on the natural and social world and our relationships with them, and also depending on how exposed we are to climate change and the different risk cultures that we come from (Hulme, 2009). Hulme (2009) notes that the same evidence will be viewed very differently by different people and institutions; for example if someone believes that the climate is inherently fragile, he is more likely to think that the 'tipping point' is going to be reached (Hansen, 2008). He then goes on to argue that looking forward we need something different than simply more scientific evidence.

As outlined above international legislation and treaties did not seem to be working and until the Paris Agreement was put into force on 4th November 2016 (United Nations, 2016) there had been no real worldwide government-led consensus on climate change; this included acknowledgement from all that climate change is happening and implied that a 2 – 4^{o}C rise is imminent (Tucker, 2012). Seventy-three countries and the EU have signed up to the Paris Agreement therefore exceeding 55% of emissions with the aim of keeping global warming to less than 2^{o}C.

Hulme asks you to transcend the current thinking and look past the technical and political wrangles and to ask 'not what we can do for climate change, but what can climate change do for us.' (Hulme, 2009). Hence, he sees climate change as a transformative opportunity for re-thinking human society. He also suggests that we need a multitude of solutions to the problem – 'rather than a silver bullet you need silver buckshot' as after all climate change is a 'wicked problem' that has no one solution and which can be correctly but partially framed in a multitude of different ways (Barth and Michelsen, 2012; Incropera, 2015). He also asks if we are 'eco-centric or ego-centric? Is it about us using the universe and consumption or is it about sharing the universe with the rest of the life that is on the planet? (Hulme, 2009)' His more recent work (Hulme, 2014a) develops some of these themes into a call for a resurgent interest in the old tradition of 'value ethics' (based on Aristotelian and Christian thinking).

Hence he suggests that climate change requires ethical and emotional responses rather than merely technical and scientific ones (Hulme, 2014b).

'Dark Optimism' is an approach that embraces a local, resilient culture in the future that will enable people to live in a different way but in-keeping with the changes that climate change will bring. It asks people to accept that the future will be 'dark' but that there is a way forward (Chamberlin, 2013). Hamilton (2010) brings a third idea to the table, that of civil disobedience; even if the governments of the world do act in a unified way, do all the things that they have agreed to do, it will be too late and thus a hollow victory, therefore he asks if *'the time has come for us to ask whether our obligations to our fellow humans and the wider natural world entitle us to break laws that protect those who continue to pollute the atmosphere in a way that threatens our survival.*' (Hamilton, 2010).

3.7 Deep Learning and Threshold Concepts

Deep learning is an approach to learning that emphasises holistic and transformational study, rather than learning by rote or 'surface learning', as typified by how many people would endeavour to learn for an exam (Beattie, Collins and McInnes, 1997), although carefully crafted continual assessment and exams may lead to deep learning (Rushton, 2005).

'Threshold concepts' is a relatively new pedagogical term that concerns the concept of learning about difficult or troublesome topics that are portals to seeing the world in new ways characteristic of particular disciplines or outlooks, like the idea of Darwinism for biologists (Hall, 2012). Challenging academic disciplines such as physics, statistics or econometrics all have different 'core concepts' that need to be understood so that the student can be comfortable working in this field; these are 'akin to a portal, opening up a new and previously inaccessible way of thinking about something' (Meyer & Land 2003). Therefore, a threshold concept involves reaching a certain way of understanding or looking at something new – without which he/ she cannot go any further. The concept can be related to a particular subject or approach to the world and passing through the 'portal' may be very sudden or take place over a long period of time

“stuckness” (G. (University of W. Cousin, 2010) and may be a long and possibly problematic process; it may be ‘troublesome which goes against the grain of thinking and can be absurd and therefore can lead to troublesome knowledge’ (J. Meyer and Land, 2003; Hill, 2010). For example, using an evolutionary metaphor of the relationship between dinosaurs and birds and how dinosaurs evolved into what are now birds with feathers, no teeth and the ability of flight. Another threshold concept is understanding the concept of the relationship between gravity, density and mass as this is the foundation of all science and needs to be understood. Without understanding these complicated and what appears to unconnected concepts students cannot understand the basis of evolution or physics and this can then impact on all further learning (Perkins, 2010; Bar, Brosh and Sneider, 2016)

Perkins (1999) initially wrote about troublesome knowledge and split knowledge into four parts:

1. Ritual – knowledge that forms part of a routine or ritual performance e.g. names, dates etc
2. Inert – knowledge that is known but is rarely used so is available but will require prompting
3. Conceptually difficult and hard to grasp – could have a conflict of belief, experience or expectations; this kind of knowledge is most likely to consist of threshold concepts
4. Tacit – knowledge that arises from the complex, inconsistent or paradoxical knowledge or knowledge that contains subtle distinctions – e.g. mass/ weight (Perkins 2006; Hill 2010; Haldin-Herrgard 2000)

Both the deep learning and threshold concepts approaches have important implications for teaching climate change. In fact, it could be argued that climate change is a paradigmatic example of a threshold concept, being interdisciplinary (Moore, 2005; Feng, 2012) as well as combining intellectual and emotional challenges and implying deeply ‘troublesome’ implications . Hall (2010) argues that teachers frequently will impart the ‘ritual’ and ‘inert’ aspects of climate change as this will enable understanding and but find it much harder to address ‘tacit’ and/ or ‘implicit’ understanding (Hall, 2010). He goes on to talk

about the nature of uncertainty in climate change and suggests that this (i.e. uncertainty) might be one of the threshold concepts in the subject, which when reached will provide students with a *'significantly different perspective on the subject'* (Hall, 2010).

Hall (2010) goes on to mention several areas of troublesome knowledge in climate change studies that were highlighted when conducting ten interviews with Geography, Earth & Environmental Sciences (GEES) lecturers who all teach about climate change in some aspect and these include (Hall, 2010):-

- Natural variability of climate – the earth's climate has changed greatly although this is over very long periods of time and this in itself can be troublesome learning for students, this needs to be put into context so that students can appreciate that climate has been changed over a very short period of time and is due to human intervention rather than a natural phenomenon (Mann, Bradley and Hughes, 1998)
- The Earth system – the complexities of the Earth' systems can be difficult to understand and to then relate them to climate change can be troublesome for students (Libarkin, 2006)
- Scientific/ mathematical models and approaches – using equations and other mathematical formulae that students do not expect to study as part of their course (Land and Meyer, 2006)
- Uncertainty – climate change presents itself as an unknown future despite all the modelling and forecasting that is available there is still no definite future ahead, it is dependent on a variety of factors (Akter and Bennet, 2012)

Hall concludes that a possible way forward in teaching climate change is to involve all of these concepts and ideas and to use them as a framework for teaching (Hall, 2010). However, the considerable number of suggested ideas, concepts and facts of pertinence to climate change is itself a major challenge in teaching. Whilst some teachers will 'stuff' their lessons with as many facts as possible, Cousin (2006) advocates the 'less is more' approach as this will enable students to reach and cross their threshold concepts in a clearer and more understandable way. This understanding will then empower students to successfully engage with their subject (Cousin, 2006).

Increasing knowledge can result in university students feeling increasingly uncertain. School children are often taught that this is the right way to do something or that this is the only answer to a question and are prone to surface learning while at university students are taught to start thinking for themselves and to recognise that there is more than one answer to a question and that things are not black and white (Schommer, 1993; Ireland, 2010). This uncertainty in their thinking and teaching can leave students feeling disorientated and (Knight, 2006) suggests that a number of approaches can be adopted to help students deal with the uncertainties involved in higher study:

- Ensure that students do not fear failure by building a culture of discursive safety
- Encourage positive criticism within staff and student groups
- Recognise that both staff and students have an emotional investment in their education and how their ideas are developed
- Recognition that everyone comes with their own views, truths and perspectives
- Model the intellectual processes required by students
- Remember that it takes time for a concept to be understood, thought about and learnt, this can be taken further to include a social constructivist approach that includes reflective thinking and students engaging in learning (Hall, 2012)
- Teaching staff need to consider whether they are an expert or whether they should act in a more facilitative role (Knight, 2006)

Suggested ideas for moving forward after considering the above issues include:-

- Discussing dynamic issues rather than final ones
- Using historical and real life examples of scientific development, e.g. climate change?
- Showing that it is alright not to know and that we are always learning
- Showing levels of complexity broken down individually and as a whole
- Using recent metaphors for complex systems

- Encouraging student debate
- Considering role-playing scenarios
- Using collaborative and peer teaching to build a community of learning amongst students (Knight, 2006)

Hence dealing with complexity and uncertainty is challenging in any subject area, and will remain a core part of the challenge of teaching about climate change. For example, the Scottish Government recently published its report for the Scottish Climate Change Adaptation Programme under Section 53 of the Climate Change (Scotland) Act 2009 and said…

> 'We cannot eliminate all the risks we face from a changing climate. There is considerable uncertainty with future climate change. Many of the factors likely to affect the degree of future change are uncertain themselves – for example population growth and technology developments. But uncertainty is not an excuse for inaction. The challenge is to ensure that the actions we take to adapt are flexible and can be adjusted as our understanding improves.'(The Scottish Government, 2014)

Teaching climate change involves emotional as well as intellectual responsibilities; a full understanding of the topic – crossing the threshold - may have profound and difficult emotional effects. This is recognised in the literature on environmental activism and public response. For example Randall discusses how the weight of guilt or the loss that people often face towards the debt that they owe the world is often too much for them and leads to difficult emotional processes including loss, trauma, guilt, anxiety, despair and rage (Randall, 2009). She suggests that the following need to be in place for people to accept the difficult processes that they go through:-

- Greater psychological sophistication in policy, campaigning and service delivery
- Better psychological support for environmental practitioners and activists

- Political leadership that emphasized the need for both individuals and society to make changes
- Publicity campaigns that are truthful and straightforward and that attribute responsibility without inducing overwhelming guilt
- Policies that provide a strong framework for personal action, validating and rewarding it
- An emphasis on proportionality of response and boundaries for what individuals should do
- The provision of social support and affirmation to help people feel accepted and respected for action in pro-environmental ways (Randall, 2009)

These ideas are taken further by Ojala who uses hope as a basis for coping with denial, helplessness and hopelessness, by using positive aspects that will encourage young people to be constructive when learning about climate change and help them to engage in the subject (Ojala, 2012a).

Activism is included in evaluation of student's values through improving community feeling by improving the world through activism or generativity in which the goal is to work to create change (Crompton, 2010). There are three parts to pro-environmental behaviour; purchasing green products, services etc, good citizenship through minimising consumption or reducing waste and thirdly environmental activism, so being an activist is a part of changing behaviour (Coelho *et al.*, 2017)

Such sensitivities are also relevant to the teaching of climate change in Higher Education. Therefore, there is a need for both deep learning when understanding climate change (Walton and Carr, 2011), a wicked problem (Bellamy and Hulme, 2011; Hulme, 2014b) and consideration for the emotional impact of going through a threshold concept and understanding multidisciplinary concepts and uncertainty around climate change (Woodland and Hill, 2010).

3.8 Resilient learning

Many children and adults in the western world are kept relatively sheltered from the world, it is generally a safe place to live without war, famine etc. on our doorsteps. War, famine, drought are in different parts of the world; although we see these things on TV or read about them we can successfully block them out (Norgaard, 2006; Slovic, 2007). Another possible reason for this successful blocking is that parents do not tell their children that there are possible dangers in the world, due to their perceived vulnerability and the parental desire that children should live in a safe, riskless society, Malone calls these parents and their children "bubble-wrapped" (Malone, 2007).

Anxious parents and their progeny are surrounded by a 'culture of fear' which then leads them to be 'bubble-wrapped' (Malone, 2007). Children are not taught about the dangers that exist in the world and are considered to be inherently vulnerable and therefore need to exist in a risk-free environment (Duhn, 2012). This then leads to teachers who are anxious not to upset and therefore do not teach potentially challenging, complex subjects like climate change (Elliott and Davis, 2009).

How then are these children of the future who have been brought up 'bubble-wrapped' able to engage in such a complex subject like climate change – maybe this is another reason why the level of engagement of most higher education students is not as high as it should be?

Sterling suggests that by ensuring we teach climate change in such a way that moves forward from old teaching and towards a new approach that includes resilience theory and sustainability we can then empower learners to move forward into a world which is uncertain and full of threats and surprises (Sterling, 2010). Using the four 'R's outlined by Claxton as a starting point to resilient learning with resilience, resourcefulness, reflection and relationships as the four cornerstones for successful knowledge (Claxton, 2002; St Peters Childcare, 2008).

UNICEF endorse this need for teaching climate change to all children, their view is that by teaching young children about climate change and 'future-proofing' them they can move forward into an uncertain world but with the necessary

skills to equip them to deal with it. UNICEF takes this thought further and says that children have a right to know what is happening to their planet and what they are going to inherit. As Anthony Lake the Executive Director of UNICEF writes

> *"As the effects of climate change become more visible and extreme, they are likely to affect adversely the lives of children and adolescents all over the world. Over 99% of deaths already attributable to climate-related changes occur in developing countries – and children make up over 80 per cent of those deaths. The challenge of climate change is huge; it requires an urgent response from all generations – and the children who will inherit the earth are the last people who should be excluded."*
> (UNICEF, 2014)

This argument strengthens the need for children to be educated about climate change and directly challenges the tendency to protect young people by avoiding discussion of unpleasant realities (Malone, 2007; Davis, 2009). So how might such discussion occur without inducing depression or fatalism?

Worsley (2014) has identified common qualities amongst individuals who are able to bounce back from hard times and keep going. The resilience doughnut is a tool for all ages that can build a culture of resilience and help them to keep on going through professional or personal challenges. The doughnut enables people to cope with stress and think ahead to the future while focusing on the positive aspects of their lives and then allowing these to spread across all of the doughnut's aspects which strengthens adults, young people's and children's emotional resilience (Worsley, 2014).

The resilience doughnut is a conceptual way of coping successfully with adversity by mapping a person's ability to deal with situations, the resources that they can draw upon and the level and/or the presence of adversity that they have to deal with. The doughnut is split into internal and external sections, with the internal representing the internal individual characteristics and the outer circle signifying the external contexts that a person will develop. The outer circle is then divided into seven areas of a person's life that they can

explore and develop further to build resilience: the parent factor, the skill factor, the family and identity factor, the education factor, the peer factor, the community factor and the money factor (Worsley, 2010).

Figure 1a: The Resilience Doughnut framework

Another option is to use meaning focused coping mechanisms whereby people can call on their own beliefs, values and existential goals to maintain emotional wellbeing. This approach can work as it acknowledges the problem, particularly when it cannot be removed or improved upon but can help people including young people to deal with the stress or other emotions and help them move on when active participation is required, such as when caring for a terminally ill partner (Ojala, 2012b)

These options provide resources for educators and campaigners that could prove useful in facing the emotional challenges raised by climate change education.

Hence the literature suggests the imperative of teaching difficult subjects but the need to acknowledge potential emotional impacts and be aware of resources to deal with those.

3.9 Conclusion

The literature discussed above shows that climate change is a complicated subject to learn and to teach for a wide range of reasons. These include the subject's inherent complexity and uncertainty, the emotional impact it can raise and the associated denial that might cause, the social and political forces that distort and obscure the truth and the possible perception amongst many students that they already understand it, given the frequent but superficial and distorted exposure the topic receives. The pedagogical challenges and opportunities raised by threshold subjects, uncertainty and resilience seem particularly relevant when considering the teaching of climate change. As these notions make clear, emotional responses are central to deep learning; this is arguably true of any subject but is particularly the case for climate change.

The methods used for data collection and analysis are discussed in the next section with the core aim of exploring the relationships between emotion and learning about climate change.

4.0 Methods

4.1 Background

Two questionnaires were designed with the aim of exploring students' knowledge and emotions towards climate change, and how explicit teaching about climate change alters both knowledge and emotion. A 'preliminary' questionnaire asked students their views prior to having any formal climate change teaching and a post-lecture version then asked similar questions about

three weeks later to assess their change in knowledge and emotional response. A total of 12 questions were asked in the preliminary stage.

The climate change lecture was a two-hour lecture conducted in a large, tiered lecture theatre. The lecture incorporated traditional didactic practice as well as interactive windows that were inclusive exercises designed for student interaction, reflection, discussion and problem solving (Huxham, 2005).

These were repeated in the post lecture questionnaire, completed three weeks after the lecture, and an additional three questions were also asked, two designed to evaluate the students' emotional and learning response to the information that they had been taught and one to solicit volunteers for a follow-up focus group.

The questionnaire was a self-completion questionnaire and was piloted with 7 people, 2 of whom were in secondary school and the remaining 5 were aged between 18 – 22 years old but were not in full time education. The pilot was conducted not to test validity but to test language clarity and check that the questionnaire layout was clear and understandable, the two secondary school participants gave useful feedback and were hence included. Following this pilot some questions were re-worded for greater clarity.

The questionnaire was comprised of mostly closed questions that asked for an opinion rating and a 7-point likert scale was used for answering. Other questions were multiple choice with an 'other' specify option and there were three demographic questions: gender, year of course and degree being studied (see Appendix 1). Gender was subsequently explored as a predictor variable in a number of the analysis. This was because the literature on environmental beliefs and behaviours often shows gender to be a significant factor (Kollmuss and Agyeman, 2002; McCright, 2010; Nurse, Benfield and Bell, 2010; Arora-Jonsson, 2011). Two contrasting programmes of study were examined, life sciences and sociology. Life sciences was chosen because it was anticipated that these students would have a relatively detailed knowledge of climate change already having chosen courses that had climate change as a core part of their and because they are taught climate change science at various points

in their course, permitting a before and after analysis. Sociology students – as a non-science course – were chosen as a contrast.

It was decided not to differentiate between the different biology and ecotourism students as the climate change lecture was conducted early in the first year of teaching it was felt that they were all at a similar level in their course and therefore would not be too many differences in teaching at that time. It was also felt that the number of students in some of the courses was too low to explore such as microbiology (3 pre and 1 post) and environmental biology (6 pre and post).

The questionnaire was handed out at the beginning of lectures to all students and was then collected back at the end, so enough time was allowed for students to complete it if they wished to do so. A total of 209 students, a first year life science class (109 questionnaires), a third year life science class (20 questionnaires) and a first year sociology class (78 questionnaires), completed the questionnaire prior to any specific climate change education. A post-lecture questionnaire was handed out on 26th October 2012 to the first year life sciences class and a total of 87 were returned, this was about 3 weeks after the class had had their climate change lectures so that they had had time to assimilate their learning. A total of sixty-nine respondents completed both the pre and post questionnaire.

All students who completed the second questionnaire were also asked whether or not they would like to attend one of two focus groups, to discuss climate change and the best ways of teaching the subject. The students were told that the groups would take no more than an hour, beverages and snacks would be provided and a that everyone who attended would be entered into a £25 Amazon voucher prize draw for each group. A total of seventeen students said that they would like to come along to one of the focus groups however after various recruitment drives and reminder emails there were only three attendees at the focus group. The focus group took an hour to moderate and was very energetic and focused.

An additional four in-depth interviews were conducted; two with people who had attended the focus group and two with second year Biology students. A semi-structured interview protocol was used to raise open questions about long term changes in emotion, knowledge and action. Both the interviews and the focus groups were recorded using an audio recording device.

4.2 Questionnaire design

The questionnaire was designed to capture both the levels of perceived and actual knowledge about climate change and the emotional responses of the students to this knowledge. The subject matter taught in the climate change lecture was the key determinant to the questions asked in the questionnaire and these together with those linked to recognised emotions and feeling when talking or thinking about climate change were asked (Klein, 2013; Landry *et al.*, 2018). Literature reviews on teaching climate change were conducted at the time of the questionnaire design there was nothing found in the literature that could help with specific questionnaire design and it was therefore written for this research (Krosnick *et al.*, 2009).

4.2.1 Knowledge Score

The knowledge score was compiled using the following questions:-

> Q1. How well do you think you understand the issues surrounding climate change?
>
> Q5. What do you think are the likely effects of climate change over the next century?
>
> Q6. Which of the following are greenhouse gases?
>
> Q7. Increases in global average temperature over the past fifty years have been caused by..?

A score was given for each answer; for Q1, which concerned self-assessment of climate change knowledge, the Likert scale was a negative score going up to a positive score for those with the most knowledge.

1 (-3)	2 (-2)	3 (-1)	4 (0)	5 (+1)	6 (+2)	7 (+3)

Q5, Q6 and Q7 all concerned factual knowledge about climate change. They were all scored with a ‘1’ if the answer was correct and a ‘-1 if the answer was incorrect. Each question was scored and the answers were then added together to get a ‘total knowledge score’. Hence the composite knowledge score reflected both perceived and actual knowledge of climate change. These elements were combined since perception of knowledge – as well as ‘objective knowledge’ is likely to influence emotional responses, and the relationship between knowledge and emotion was a key interest in this research.

4.2.2 Emotional Score

A similar exercise was conducted with questions Q2, Q3 and Q4 which were:-

Q2. How worried are you, if at all, about the effect of climate change on the planet?

Q3. When you think about what is happening to the world with regard to climate change how or what do you feel?

Q4. How important do you feel that climate change and the issues surrounding the potential implications of climate change are?

Questions 2 and 4 were again scored with a Likert scale from 1 to 7 as shown above and were again re-coded from -3 to +3. Respondents were allowed to tick up to three of the closed responses for Question 3, which presented a range of options capturing negative, neutral and positive or dismissive emotional responses. These received positive (+1) scores if they indicated a ‘difficult’ or negative emotion e.g. angry, overwhelmed or scared. Emotions or thoughts such as ‘it’s not true or ‘not concerned about it’ were scored a ‘-1’. While non-committal or don’t know enough about it were scored a ‘0’.

Each respondent’s answer was recoded and a total emotional score was calculated.

4.3 Quantitative Methods

The main questionnaire was handed out on the 28th September to the first year life science class and a total of 109 were returned. A further 20 questionnaires

were completed by students in an honours year biology class (1st November) and an additional 78 were completed by first year sociology students (27th November), giving a total of 205 questionnaires that were completed prior to any specific climate change education.

The second questionnaire was handed out on 26th October to the first year life sciences class and a total of 87 were returned, this was about 3 weeks after the class had had their climate change lectures so that they had had time to assimilate their learning.

Data from all questionnaires was entered into Excel and the results were analysed using Minitab17 and Snap. All respondents were asked to give their matriculation number on both the pre and post-climate change lectures so that those respondents who answered both the pre and post climate change questionnaires could have their answers matched (in Excel) and explored for change.

All respondents who took part in the survey were invited to take part in a focus group to discuss climate change in more depth.

4.4 Statistical Methods

Statistical analysis was conducted using Minitab Version 17 for regression analysis and Snap Survey Software was used to run computer tabulations which included paired t-tests and chi squared tests.

In order to explore how changes in knowledge might affect changes in emotional response, composite scores for ‘knowledge’ and ‘emotion’ were constructed. The former involved summing results from Q1+Q5+Q6+Q7 and the latter from Q2 and Q3; higher values implied higher knowledge (self-perceived and actual) and stronger emotional commitment respectively. Using the matched pre and post lecture questionnaires for individual students, a single value for knowledge change and emotional change was generated per individual by subtracting the pre from the post lecture values. Relationships were tested using regression analysis and residuals were examined to ensure statistical assumptions were met (see Section 5.12 and Appendix 2).

The use of appropriate statistical tests requires examination of both expected distributions and actual residuals. In these cases, it was anticipated that combining individual scores would produce long enough scales to meet assumptions of normality. Looking at the residuals of the tests suggests this approach worked. Choosing non-parametric tests in these circumstances would have meant inflated type 2 error.

4.5 Segmentation Analysis Methods

The answers that the respondents who completed both the pre and post questionnaires answers were analysed in more detail and after assigning each respondent a group (see Appendix 3) depending on their answers. Segmentation analysis is a market research methodology that explores the respondent's views, opinions, attitudes and actions and groups them into similar types of people. A good example of segmenting is to look at the ways that people start using new technology like internet banking, who can then be grouped into early-adapters, adapters or non-adapters (Patsiotis, Hughes and D.J., 2012). Segmentation is used in various areas including health promotion so that promotions are targeted at the groups that are the most receptive and in global warming engagement campaigns (Slater and Flora, 1989; Maibach *et al.*, 2011).

4.5 Qualitative Methods

Of the thirteen students who had agreed to take part in a focus group two actually came along to the group, and one of the students brought a friend who was on a different course but keen to talk about climate change. The students were emailed invitations to one of two focus groups, tea and biscuits were provided and everyone who came along was entered into a prize draw to win a £25 Amazon voucher. Six of the students who said that they wanted to take part in the groups were male and seven were female. All the respondents who were interviewed in the qualitative phase were female.

The focus group took 70 minutes to conduct and involved questions around their emotions and feelings around climate change, level of knowledge about the subject and when/ how they learnt about climate change. Teaching

methods were also discussed and what methods could be used to engage with students.

Four additional in-depth interviews were also conducted with students, two of whom had come along to the focus group. Interviews took between 30 and 50 minutes to complete with an average time of 42 minutes.

The focus group and depth interviews were all recorded using a digital voice recorder and transcribed into written form. The transcripts of the focus group and depth interviews were analysed using thematic analysis (Boyatzis, 1998) using an inductive approach which allows a way of identifying, analysing and reporting patterns or themes within data. Using an inductive approach allows for themes to arise from the data itself rather than from the research questions or an existing theoretical viewpoint (Braun and Victoria, 2006).

Analysis follows a step-by-step approach, immersing in the data and familiarising yourself with the data, generating codes and themes, analysis of codes and combine these into themes, reviewing themes and then exploring how they apply to the research (Brandling *et al.*, 2011).

It is worth noting that although I have a clear interest in climate change and have a background of campaigning on climate change and other social issues I have always conducted interviews and focus groups with no expectation's that others will agree with my views and understanding, therefore although I may interpret the findings with my personal view I do not feel that I conduct interviews that show my feelings or views.

4.6 Ethical permission

Permission to conduct this research was obtained from the Faculty of Health, Life and Social Sciences ethics committee. All respondents and interviewees were assured of their confidentiality and data was stored securely.

5.0 Quantitative Results

5.1 Introduction

This section explores the quantitative data and looks at the differences between gender and course studied and whether there were any changes in understanding or emotion after the climate change lectures. All significant differences are reported using a 5% threshold ($p = 0.05$) unless otherwise stated using paired t-tests.

The first part of the results shows the data trends between respondents who completed the first (pre-climate change lecture questionnaire) and the differences in gender and course type have been explored.

The second part of the results shows the differences between understanding and emotion using the data from the sixty-nine students who completed both questionnaires.

Of the 205 respondents that took part in the initial questionnaire 127 were studying life sciences which included biology, micro-biology, bio-medical sciences, forensic biology, animal biology and environmental biology. 78 of the remaining respondents were studying sociology. There were 62 male students and 141 female students taking part in the study.

The proportion of men versus women for the combined biology course is 29% male versus 67% female (4% not answered) and for the sociology course is 28% male versus 72% female.

5.2 Self-reported understanding of climate change

The perception from most students was that they did not really understand the issues around climate change (32%) while slightly more said that they felt that they understood the subject extremely well (39%). While 28% gave a middle score indicating that they knew some knowledge but were not confident about their knowledge.

There was a significant difference between genders for the self-reported understanding of climate change prior to any education as men reported a higher level of understanding (mean = 0.4, std dev = 1.33) than women (mean = -0.4, std dev = 1.22), (*t test, t = 4.05, df = 107.5, p=>0.001).* Thus showing that they were men were confident of their knowledge.

There was also a difference in mean scores between course types with biologists reporting a higher mean score (mean = 0.3, std dev = 1.02) than sociologists (mean = -0.5, std dev = 1.47) (*t test, t = 4.23, df = 121.6, p=>0.001)*. It was expected that biologists would tend to have the perception that they knew more knowledge about climate change than sociologists.

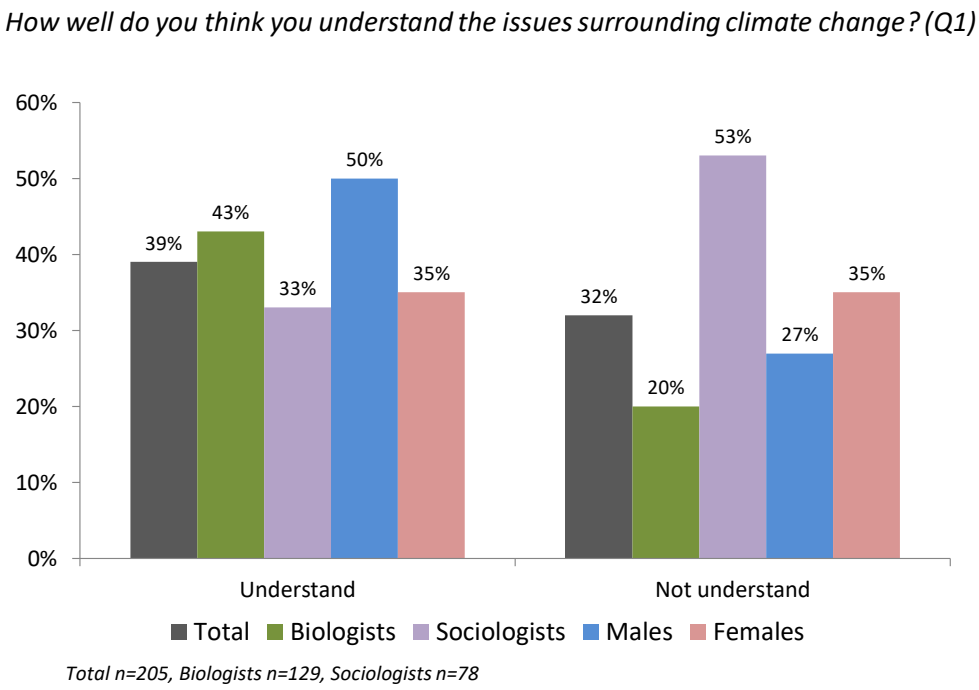


Figure 1: Scores for self-reported understanding of climate change (Q1)

5.3 Actual knowledge reported about climate change

In order to gauge students' knowledge of climate change they were asked to assess a series of possible consequences of climate change, some of which

had been directly addressed in the lectures and others either implied or not addressed. It is positive to note that the key reasons for climate change such as global increase in temperature, an ice-free arctic ocean and rising sea levels were all answered correctly by the majority of students.

However, students did not show high awareness of some key climate change impacts not directly taught in the lectures. For example 37% claimed that there would be a rise in global oceanic pH, whereas the pH will decrease as the oceans become more acidic (Nicholls, Woodroffe and Burkett, 2009). Around 15% of students also thought that there were would faster temperature rises at the tropics than at the poles and that global rainfall would be reduced – which are both incorrect.

Although men reported a higher awareness or knowledge of the effects of climate change when asked what they thought were the likely effects of climate change their answers were very similar to those given by females and there were no significant differences between the two groups. There was however but there was a significant difference of the consequences of climate change between course types with biologists having a higher mean score (mean = 1.4, std dev = 1.3) than sociologists (mean = 1.0, std dev = 1.39), (*t test, t = 2.06, df = 153.6, p=0.041).*

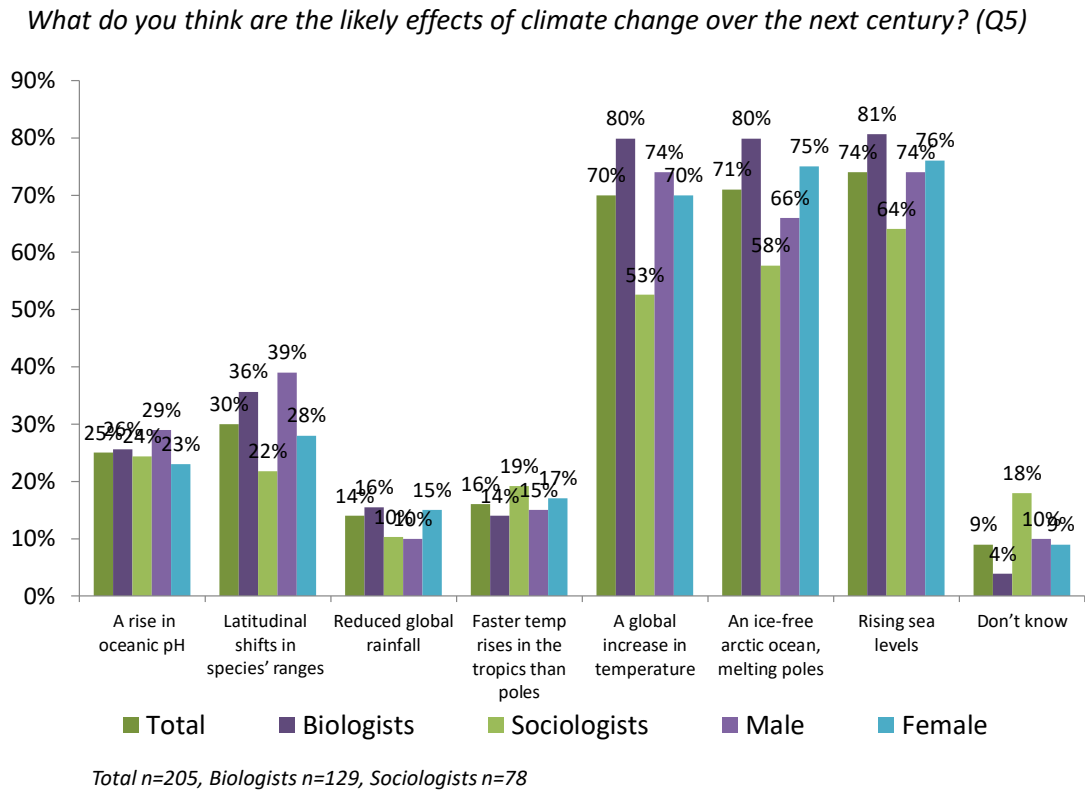


Figure 2: Awareness of the likely effects of climate change in the next century

When asked about their knowledge about greenhouse gases just under three-quarters were aware that Carbon Dioxide was a greenhouse gas (71%). General knowledge regarding other greenhouse gases, methane, water vapour and fluorinated gases, was quite low. However, the percentage of students identifying hydrogen sulphide and sulphur dioxide – neither of which are greenhouse gases – also increased indicating confusion about which were greenhouses gases.

There were no significant differences between gender in awareness of greenhouse gases but there was a significant difference between course types as sociologists were significantly more likely to say 'don't know' (29%) than biologists were (9%) *(t-test, t=-900.87, df = 67, p=>0.001).*

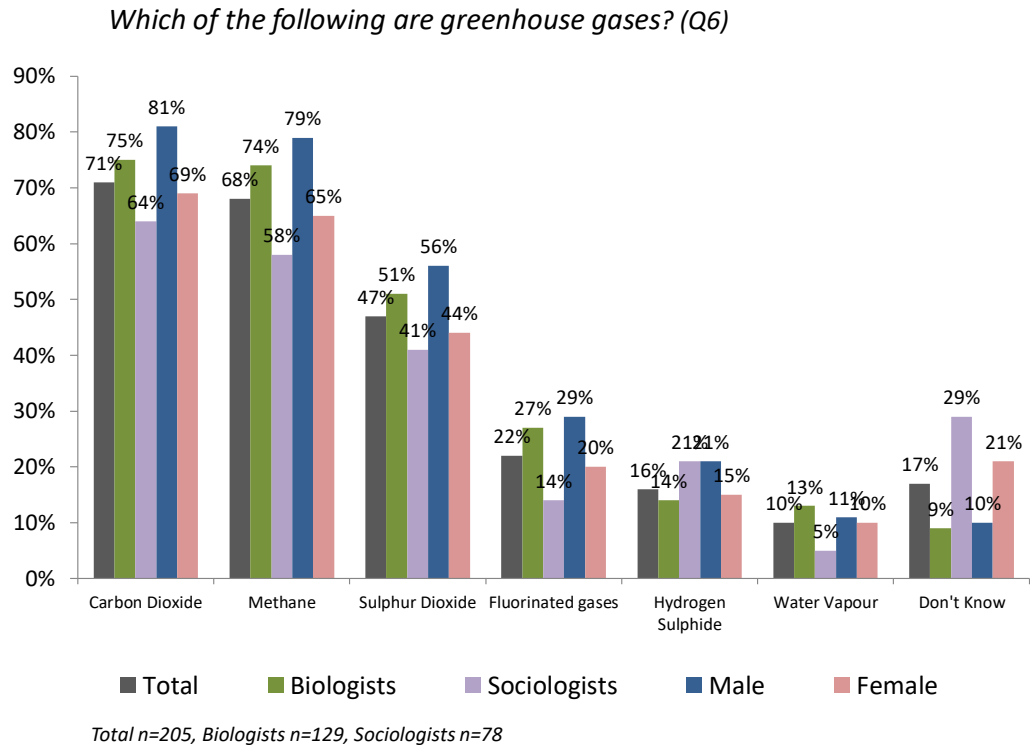
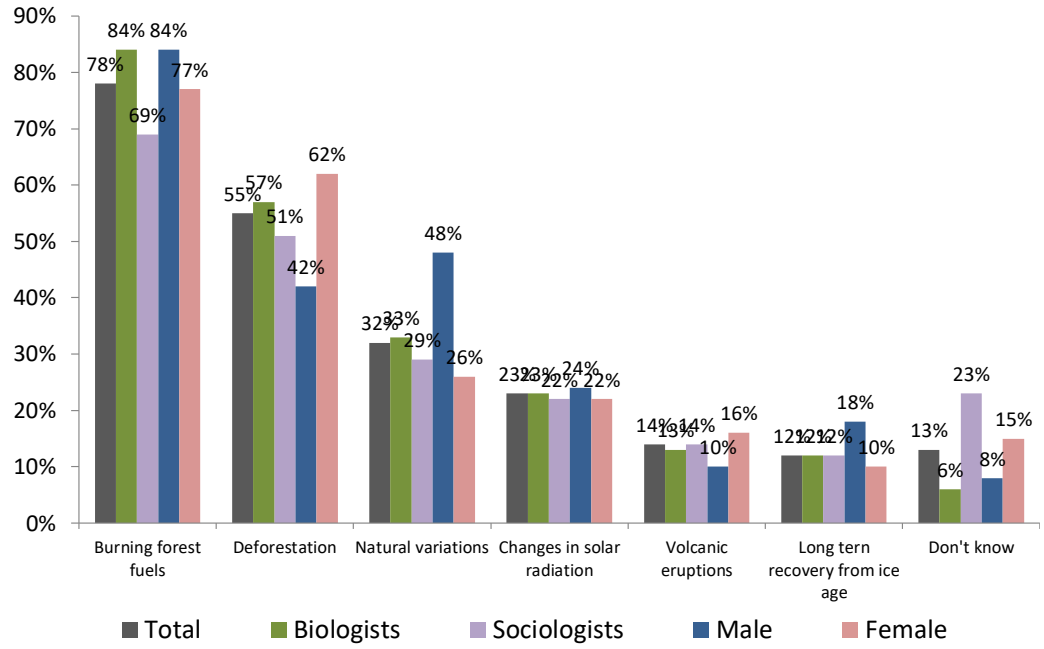


Figure 3: Awareness of greenhouse gases

Students were also asked about their awareness of the reasons for climate change and although most knew that burning fossil fuels was the biggest cause of climate change followed by deforestation, worryingly many still thought that it because of natural variances in the earth, volcanic eruptions, changes in solar radiation or long term recovery from the last ice age which are all incorrect. Men were more likely to say that they thought it was due to natural variations (48%) than due to deforestation (42%) showing that they perception is higher than their knowledge.

There were no significant differences between gender or course studied although it is clear that those studying social sciences were more likely to say that they did not know or to give the correct answer compared to biologists but that would be expected due to the nature of the course.

Increases in global average temperature over the past fifty years have been caused by? (Q7)



Total n=205, Biologists n=129, Sociologists n=78

Figure 4: Awareness of the reasons for the cause of climate change

5.4 Emotional responses when asked about climate change

Just over a half of students said that they were worried when asked about the effects of climate change (53% - score of 5, 6 or 7) while under a third said that they were not worried (29%) while just under a fifth gave a middle score of 4.

There were no significant differences in worry between the course studied i.e biology versus sociology but there were differences in gender with men (mean = 0.0, std dev = 1.58) reporting a significantly lower mean score than women (mean = 0.5, std dev = 1.36), (*t test, t = -2.16, df = 102, p=0.033)* thereby showing that women tend to be more worried about the environment and about climate change than men do.

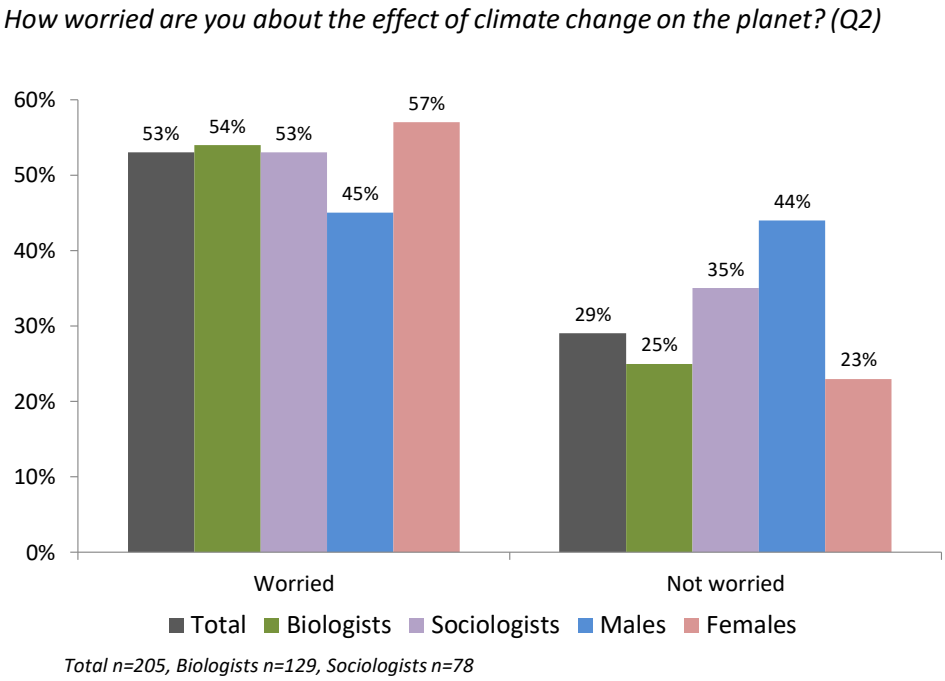


Figure 5: Self-reported level of worry (Q2) about climate change in pre and post lectures

Students were asked to identify their emotions when they thought about what was happening to the world because of climate change and a range of emotional responses were recorded. The most overpowering thought was that more needed to be done (58%) followed by powerless (36%), helpless (34%), frustrated (29%), angry (22%), scared (17%), overwhelmed (12%), not concerned (10%) and too much information to take in (8%). While nearly a quarter had no emotions or could not describe them (26%) and others were non-committal (5%) or believed that it was not true (1% or three people).

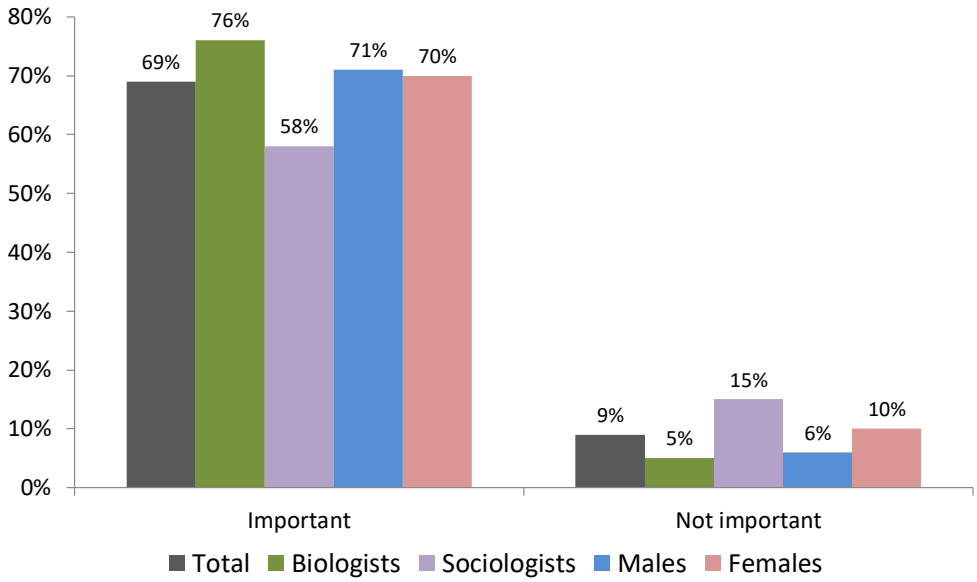
There were some differences between males and females with females feeling more scared (22% versus 6%), more overwhelmed (16% versus 3%) and felt that there was too much information to take in (12% versus 0%). While biologists were more likely than sociologists to say that they felt frustrated (34% versus 21%) or scared (26% versus 15%). While sociologists were more likely to say that they felt that there was too much information to take in (18% versus 2%) or that they did not know (40% versus 17%) compared to biologists.

Each answer was given a score depending on whether it was a positive, neutral or negative emotion or feeling and the mean scores were compared for both course type and gender. There were no significant differences between the course types with biologists having a only a slightly higher mean score (mean = 0.8, std dev = 0.59) than sociologists (mean = 0.7, std dev = 0.64), (*t test, t = 1.12, df = 151.8, p=0.264).* There was a small difference between men and women with men reporting a lower mean score (mean = 0.6, std dev = 0.69) compared to women (mean = 0.7, std dev = 0.58) (*t test, t = -0.997, df = 100.1, p=0.321)* but not significantly so.

When asked about the importance of climate change about seven out of ten people thought that it important while around a tenth felt that it was not important. Sociologists were more likely to say that they did not feel that it was important compared to biologists (15% versus 5%) while more females then men felt that it was not important (10% versus 6%). Females reporting that they do not feel that it is important could be due to a lack of understanding about the actual science of climate change but is unexpected based on other answers.

There were no significant differences when asked about the self-reported importance of climate chance between genders, both mean scores were 1.3 but there was a significant difference between course types with biologists having a higher mean score (mean = 1.4, std dev = 1.3) than sociologists (mean = 1.0, std dev = 1.39), (*t test, t = 2.055, df = 153.6, p=0.042).*

How important do you feel that climate change and the issues surrounding the potential implications of climate change are? (Q4)



Total n=205, Biologists n=129, Sociologists n=78

Figure 6: Importance of climate change and its implications for the future

5.4 Knowledge and Emotion Overall

When looking the overall relationship between gender and course type, analysis was conducted looking at the differences between the four groups; male sociologists, female sociologists, male biologists and female biologists. When looking at the combined emotional score there were significant differences between the groups *(One way ANOVA: df=3, fvalue=2.88, p=0.037).*

When looking at the relationship between the four groups there were significant differences between the knowledge scores with showing that gender and course type have made a difference in understanding and awareness of climate change *(One way ANOVA: df=3, fvalue=9.51, p=>0.001).*

5.5 Climate change actions

When those who only completed the first questionnaire were asked what actions could be taken in the future, only a minority said that they did not know

or that nothing could be done (3 people) while the most popular response was expansion in renewable energy (45%).

Differences in gender were highlighted as female students were consistently more likely to say that something should be done about climate change than male students. This is shown when asked about if more recycling needs to be done as significantly fewer male students compared to female students (58% versus 78%) *(t-test, t=2.913, df=201, p=0.004)* and again when asked if climate change should be taught to everyone female students were significantly more likely to tick the box compared to male students (74% versus 53%) (*t test, t = 2.988, df = 202, p=0.003).*

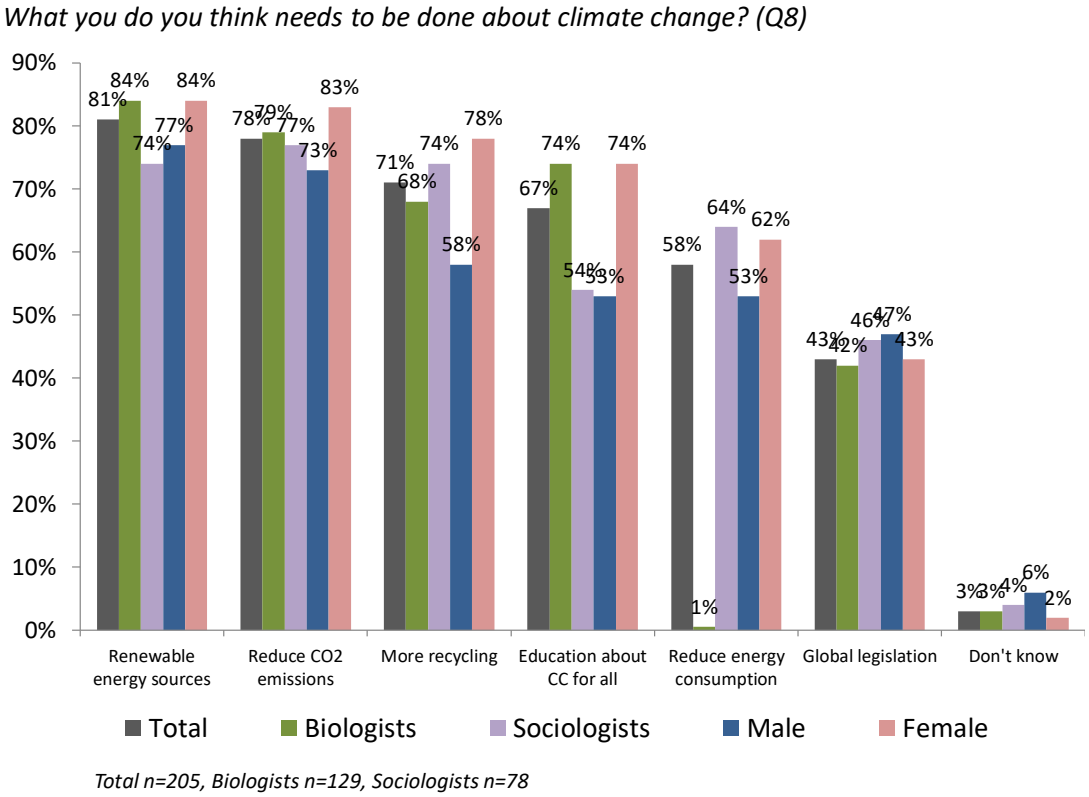


Figure 7: Climate change action (Q8)

5.6 Perception of self-reported understanding in climate change

The following section explores the changes in emotion, understanding, knowledge between the 69 students who completed both the pre and post stage questionnaires.

There was a significant increase in mean scores for the self-reported understanding in climate change for those students who completed the pre (mean score = 0.4, std dev = 1.0) and the post questionnaire (mean score = 0.9, std dev = 1.04), (*t test, t = 2.165, df = 112.3, p=0.033).*

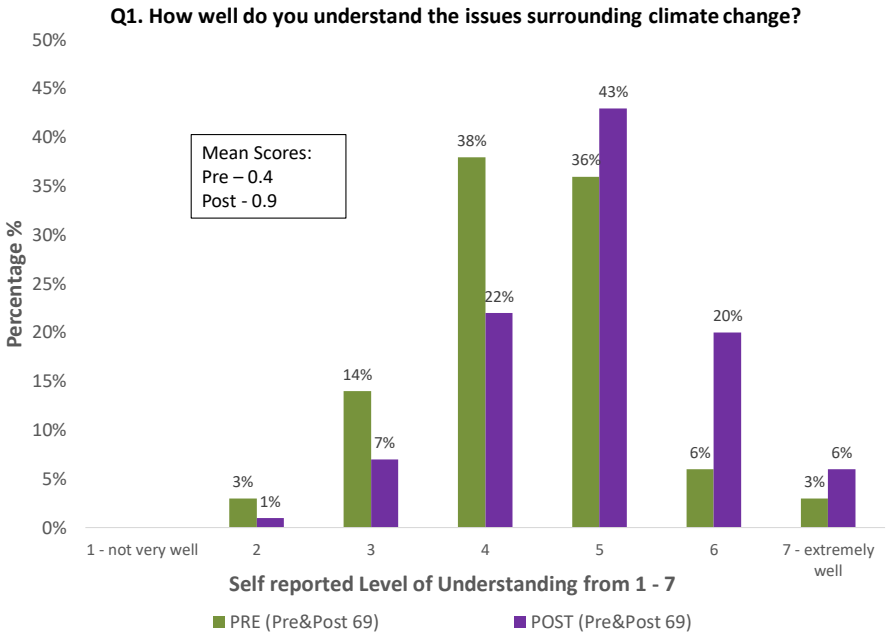


Figure 8: Comparison of self-reported understanding in Climate Change (Q1)

5.7 Actual knowledge reported – pre and post comparison

When comparing knowledge levels around the effects of climate change there was a difference between the pre and post questionnaires. The proportions of students correctly answering rising sea levels (10%), a global increase in temperature (4%), an ice free Arctic Ocean (4%) and latitudinal shifts in species ranges (8%) all increased, whilst the percentage incorrectly suggesting reduced global rainfall went down (1%). However, there were also increases in the proportions incorrectly answering that climate change is likely to cause a rise in oceanic pH (17%) and that temperatures are likely to rise faster at the tropics than at the poles (6%). Hence changes in knowledge between pre and post lectures could not be described as a simple increase in correct knowledge, despite these topics being covered during the class and being relatively simple parts of the physical and biological models. Three respondents said don't know prior to the lectures and this went down to one after the climate change lectures.

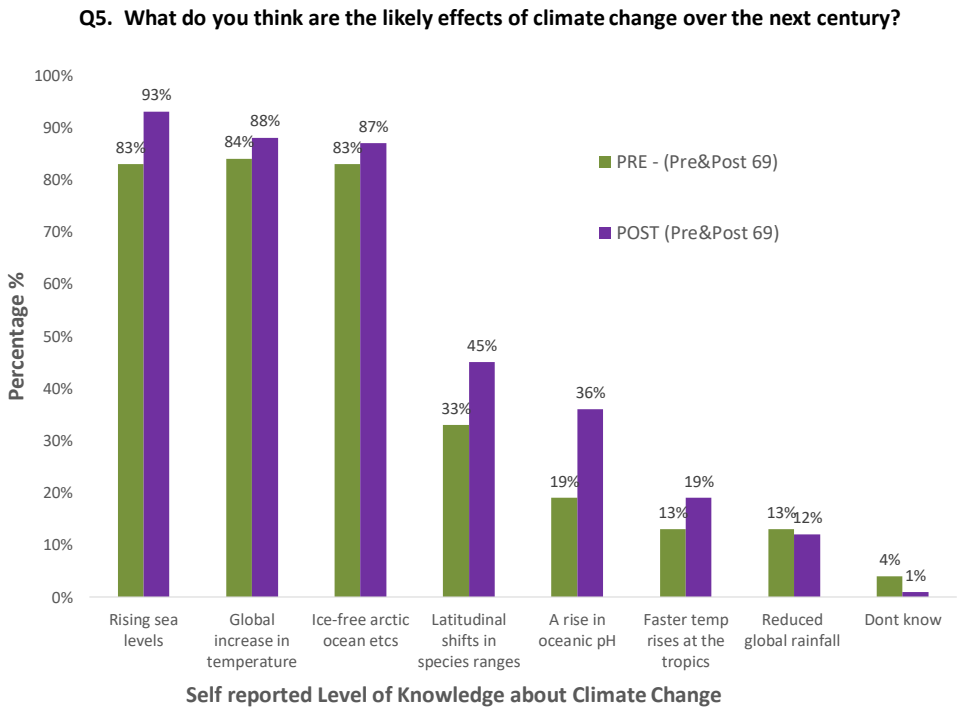


Figure 9: Comparison of knowledge levels around Climate Change (Q5)

When students were asked which gases caused climate change there was a definite increase in awareness after the climate change lectures and awareness that water vapour was a greenhouse gas increased significantly (pre = 12% versus post = 38% at p = 0.01). Of the six gases mentioned, four were greenhouse gases and two were not. Awareness of the greenhouse gases increased for all; methane (12%), Carbon Dioxide (11%), Fluorinated gases (15%) and water vapour (22%), however proportions incorrectly indicating the non-greenhouse gases Sulphur Dioxide (6%) and Hydrogen Sulphide (7%) also increased. Positively, the number of people saying don't know decreased from seven respondents to just one.

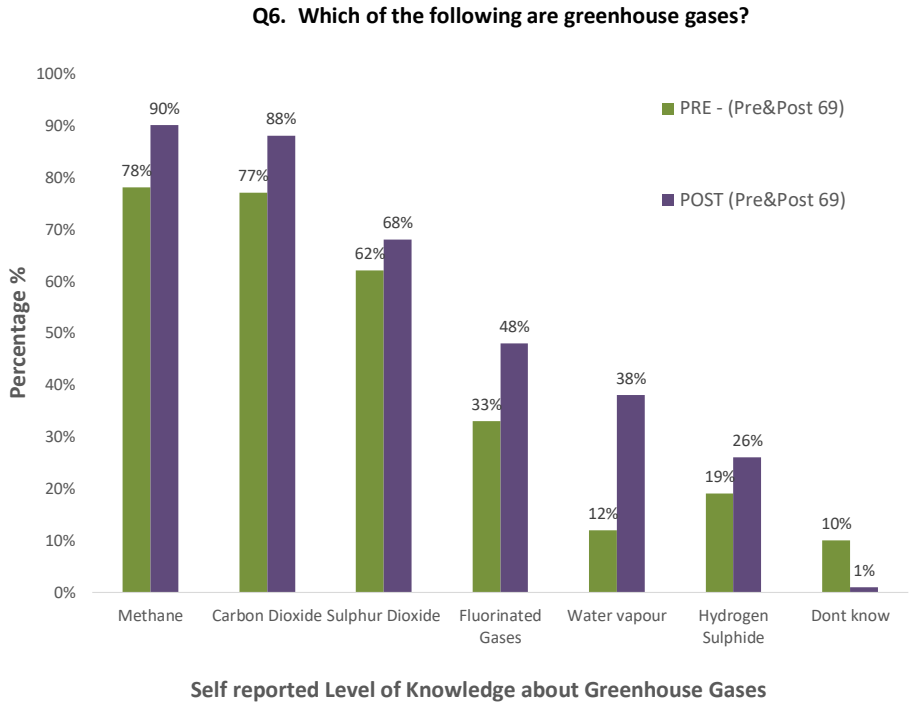


Figure 10: Comparison of self-reported knowledge on greenhouse gases (Q6)

There was an increase in knowledge when students were asked what were the reasons for the rise in global average temperature in the last fifty years. Deforestation had significantly higher proportion of students saying that this was a cause of global warming (pre = 55% versus post = 77% and p = 0.05) with an

overall increase of 22% followed by burning fossil fuels which also increased (8%).

As some of the reasons given were false it is positive to note that although they had still been ticked by some respondents overall these had all decreased, these included natural variations (4%), changes in solar radiation (6%), volcanic eruptions (3%) and long term recovery from the last ice age (6%). The number of students saying don't know also decreased from four to two.

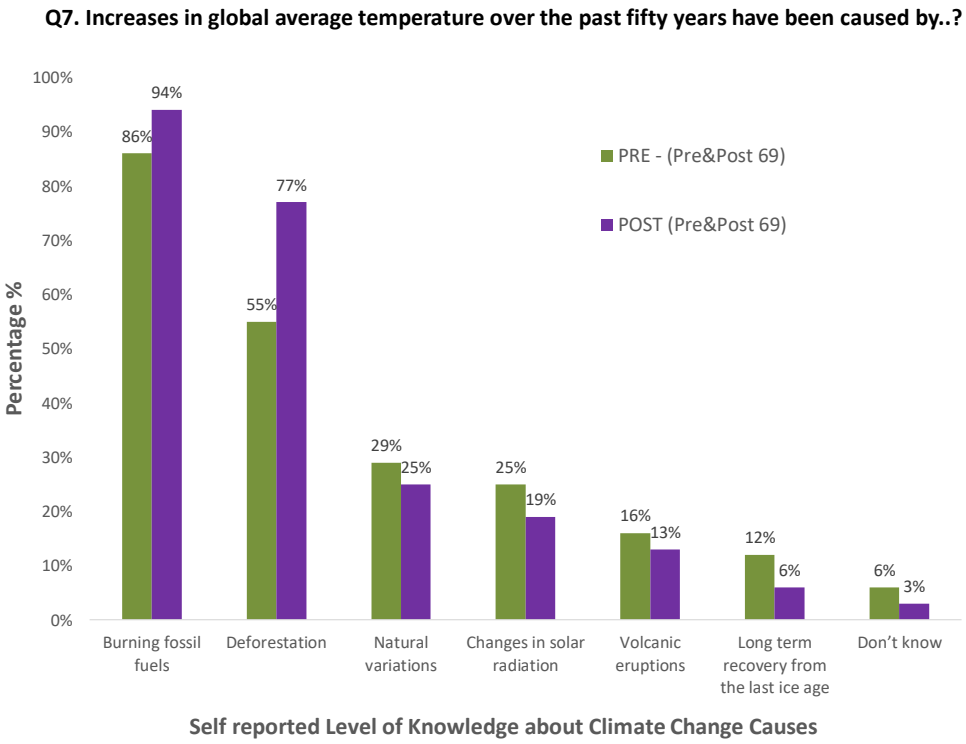


Figure 11: Comparison of self-reported knowledge about Climate Change causes (Q7)

5.7 Emotional responses when asked about climate change – pre and post

There was an increase in mean scores for the self-reported level of worry about climate change for those students who completed the pre (mean score = 0.4,

std dev = 1.47) and the post questionnaire (mean score = 0.9, std dev = 1.51), (*t test, t = 2.398, df = 113.5, p=0.018)* which was significant.

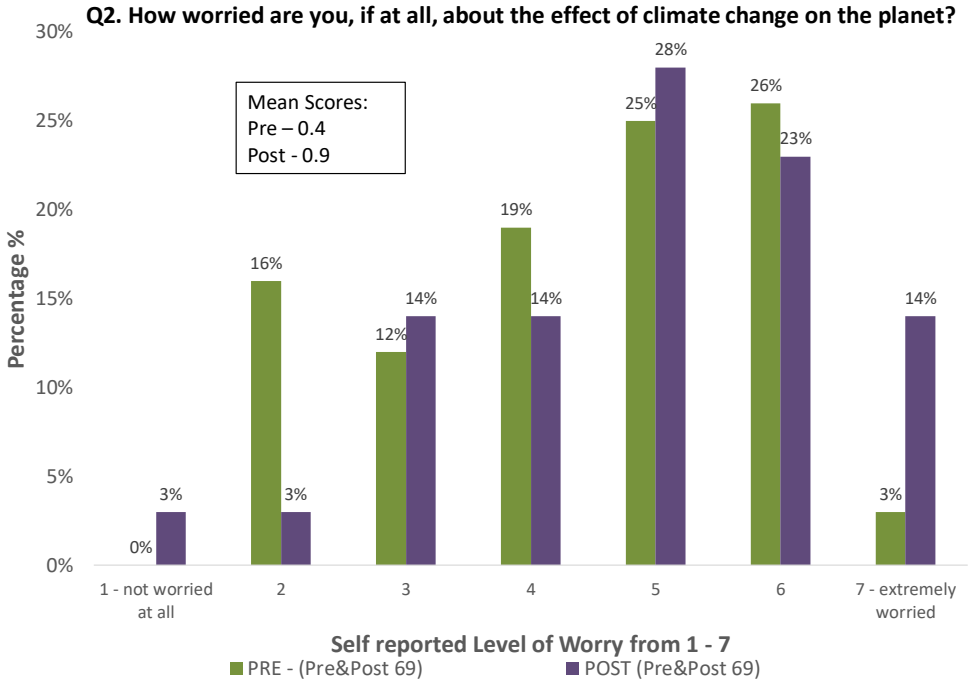


Figure 12: Comparison of self-reported worry around Climate Change (Q2)

Although there was a difference in the pre and post emotions and feelings there was no real significant findings apart from 'helpfulness' (pre = 25% versus post = 43%) (*t test, t = -900.87, df = 67, p=>0.001)*. Other changes in emotions or feelings that increased were 'powerless' (10%), 'angry' (7%), 'overwhelmed' (7%), whilst the number of people that were not concerned about it went down (9%). The number of people that expressed 'disbelief' (3%) or felt 'patronised' (3%) went up as did those who felt that there was 'too much information to take in' (7%).

The number of respondents saying 'don't know' (6%) or were 'not concerned about it' (9%) decreased, while those who were non-committal increased (2%),

there was one person who said that it was ‘not true’ after the lectures (1%) and there was another who said that it was ‘a good thing’ (1%).

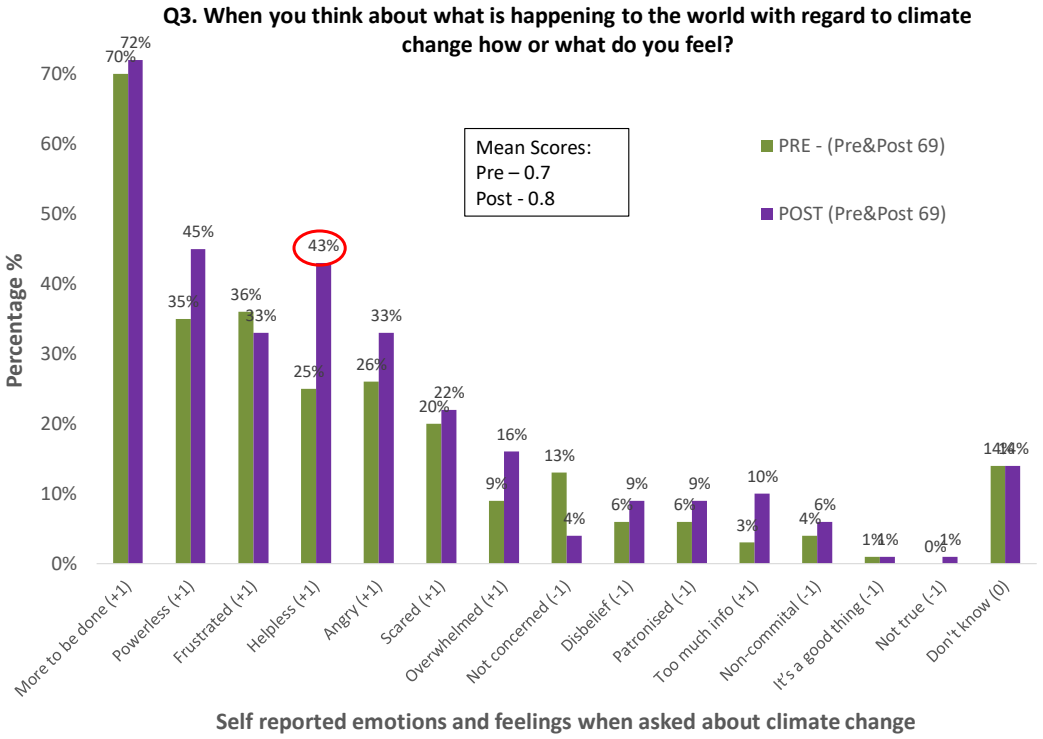


Figure 13: Comparison of self-reported emotions and feelings around Climate Change (Q3)

There was no significant differences in the levels of perceived importance around climate change and the issues surrounding the potential implications of climate change from the pre stage to the post stage. The key changes were in those giving negative answers (scores 1 – 3) as these increased (7%) while those giving positive answers (scores 5 – 7) stayed the same (83% for both stages). The shift came from those who gave mid-range score (4) as it fell (8%).

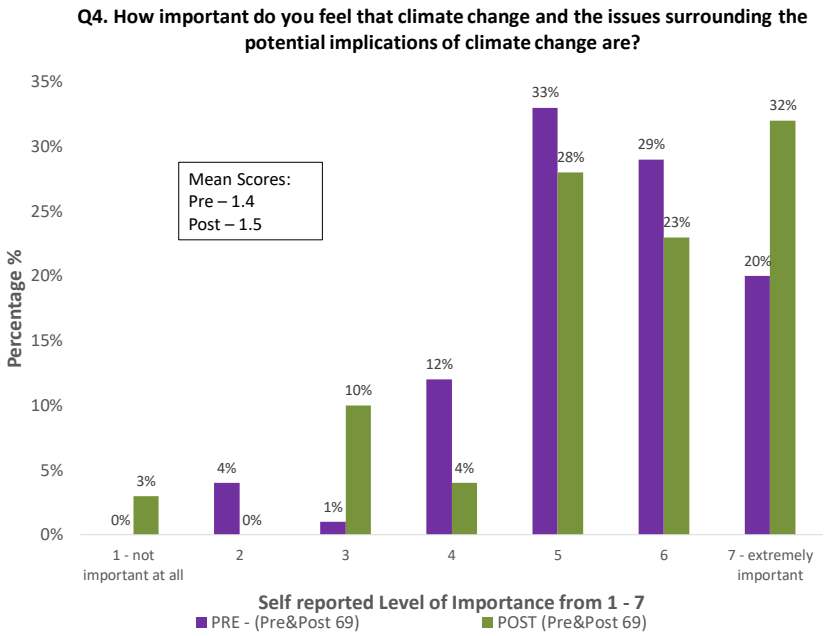


Figure 14: Comparison of self-reported importance around Climate Change (Q4)

5.20 Comparison of future action – pre and post

All students were asked what they thought needed to be done about climate change and the vast majority thought that something needed to be done. Nobody mentioned don't know for this question and the number of people saying nothing went down from two to one after the climate change lectures.

Support for all the actions increased apart from using renewable sources of energy which remained high (90%). Reducing CO_2 emissions (13%), education about climate change for everyone (15%), reducing energy consumption (16%) and global legislation (19%) all increased significantly (p = 0.05) whilst more recycling (6%) did increase but not significantly so.

Of the 69 students, thirty-one (45%) had picked all six actions, twenty-eight had picked four or five options (20% each) and the remainder had picked between one and three options (9%).

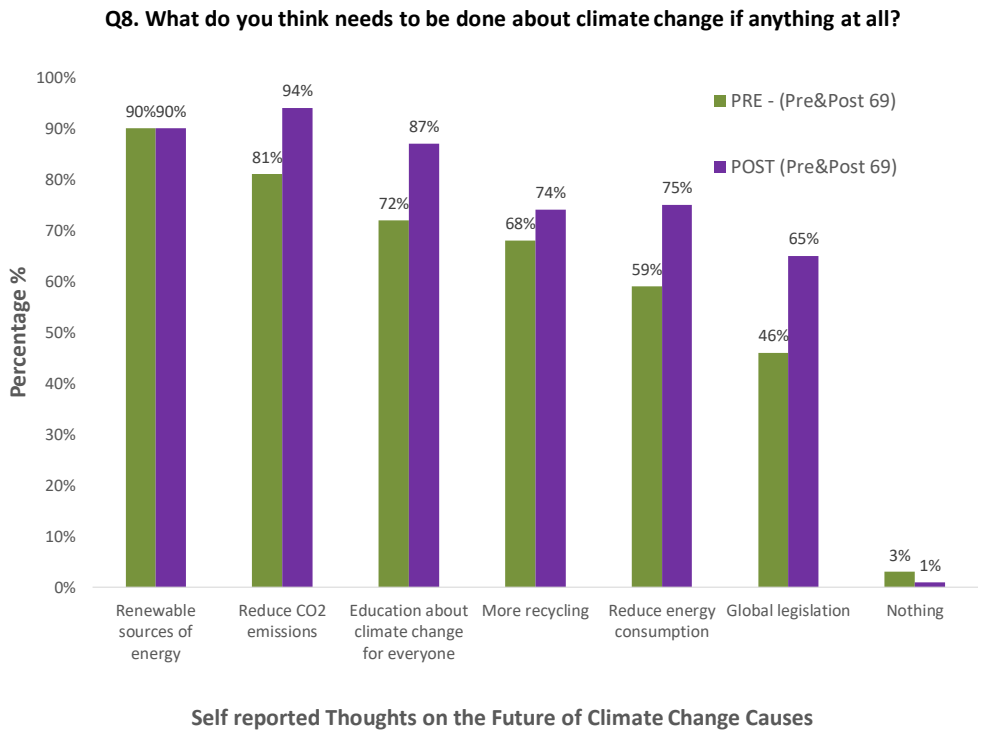


Figure 15: Comparison of future thoughts around Climate Change (Q8)

5.11 Overall relationship between knowledge of and emotional response to climate change

The overall knowledge score was compared for the pre questionnaire and the post questionnaire for all respondents and there was a significant increase in mean scores after climate change lectures (pre mean score = 4.32, std dev = 2.58 and the post mean score = 6.09, std dev = 2.48 (*t test, t = -224.92, df = 136, p=>0.001.)*

The overall emotional score also showed a significant difference once the students had had their climate change lectures as their mean scores also increased (pre mean score = 2.19, std dev = 3.14 and the post mean score = 3.39, std dev = 2.37 (*t test, t = -203.27, df = 136, p=>0.001).*

Regression analysis showed a significant, positive relationship between these scores; the greater the change in knowledge the greater the change in emotional response.

In this regression analysis emotional change was used as the response variable with changes in knowledge the predictor. However it is acknowledged that the causal arrow could and probably does go both ways here; although there is a lot of sound reasoning to think that the more you know about climate change the more likely you are to be pro-active on the subject there is also evidence that the more you know the more likely you are to switch off (Kellstedt, Zahran and Vedlitz, 2008).

The regression equation was postknow-preknow = 1.46 + 0.255 postemo-preemo, R-Sq = 6.2% R-Sq(adj) = 4.8%, df = 1,67, P = 0.038. (See Appendix 2). Hence the effect was positive and significant but also quite weak; there was a large degree of variation in the data but they did show that the lectures changed knowledge more than emotion.

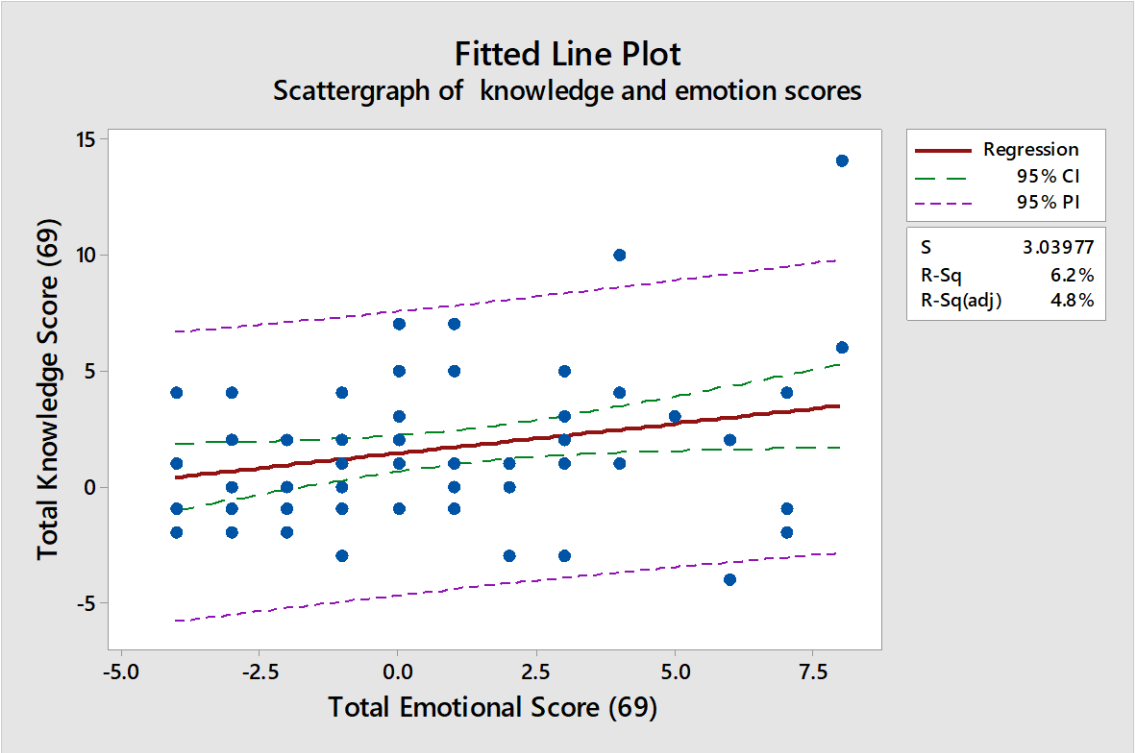


Figure 16: Scatterplot: Total knowledge versus emotion

15.12 Segmentation Analysis

It was possible to see that most respondents (22 out of 69 respondents) felt that their knowledge had increased and that they were more worried but that they had also changed their actions and would continue to do so (see Appendix 3). A further 10 respondents said that although their knowledge and emotions had remained the same their actions would be changing in the future. Generally, respondents said that they were going to change their future actions (61 respondents) and of those most were either more worried or felt the same emotionally about climate change (58 respondents) while only 3 felt less worried.

Of the 8 respondents who were not going to change their future actions 5 said that they knew less and were less worried about climate change and that they felt it was of decreasing importance to them. The remaining three respondents felt that they knew less but overall had a negative emotional response post climate change lectures and although climate change was thought to be of increasing importance

5.13 Key findings from quantitative analyses

Multiple subsidiary hypotheses have been explored in this section. However, the key hypotheses established in the introduction were:

H_1 'There is no increase in self-reported knowledge when asked about climate change after climate change lectures'

This was proved to be false as there was a significant difference in self-reported knowledge about climate change for those students who completed the pre (mean score = -0.4, std dev = 1.0) and the post questionnaire (mean score = -0.9, std dev = 1.04) (*t test, t = 3.492, df = 112.3, p=0.001).*

The overall knowledge score was compared for the pre questionnaire and the post questionnaire for all respondents who completed both and there was a significant increase in mean scores after climate change lectures (pre mean score = 4.32, std dev = 2.58 and the post mean score = 6.09, std dev = 2.48 (*t test, t = -224.92, df = 136, p=>0.001.)*

H_2 'Self-reported awareness or knowledge is not affected by gender'

This hypothesis was proved false as there was a significant difference between genders for the self-reported knowledge of climate change in mean scores with men reporting a higher level of understanding (mean = 0.4, std dev = 1.33) than women (mean = -0.4, std dev = 1.22) (*t test, t = 4.046, df = 107.5, p=<0.001).*

H_3 'There is no relationship between gaining knowledge of climate change issues and changing emotional responses to the issue'

There hypothesis was proved false as there was an increase in mean scores for the self-reported level of worry about climate change for those students who completed the pre (mean score = -0.4, std dev = 1.47) and the post questionnaire (mean score = -0.9, std dev = 1.51), (*t test, t = 2.398, df = 113.5, p=0.018).*

The overall emotional score which included worry, emotions/ feelings and the importance of climate change also showed a significant difference once the students had had their climate change lectures as their mean scores also increased (pre mean score = 2.19, std dev = 3.14 and the post mean score = 3.39, std dev = 2.37 (*t test, t = -203.27, df = 136, p=>0.001).*

H_4 'The course of study chosen, biology or sociology, has no impact on the level of self-reported knowledge or awareness of climate change prior to an introductory climate change lecture'

This hypothesis was proved false as there was a significant difference in mean scores between course types with biologists reporting a higher mean score (mean = 0.3, std dev = 1.02) than sociologists (mean = -0.5, std dev = 1.47), (*t test, t = 4.23, df = 121.6, p=>0.001).*

All of these hypotheses can be rejected. There was increased knowledge following climate change lectures and this was shown throughout the results.

Gender was significant, with males showing an increased level of knowledge about climate change but this could also be due to over-reporting and increased self-confidence and self-esteem (Goldberg *et al.*, 1977; Bleidorn *et al.*, 2016). Males also reported less concern or worry about climate change and additionally had a slightly lower overall emotional score but this could be linked to the increase in knowledge as this often leads to a lowered level of concern (Kellstedt, Zahran and Vedlitz, 2008; Tam and Chan, 2018). Females were much more likely to say that something needed to be done about climate change then males were, they were more likely to act e.g. recycle more and thought that everyone should be taught about climate change.

Actual knowledge reported by males and females was very similar (when asked about the likely effects of climate change, what the increases in global temperature were caused by and what were greenhouse gases) showing that perceived knowledge by males was overreported and that females possibly did not feel confident enough to self-report on knowledge levels.

There was a relationship between emotional responses and knowledge about climate change, although this was weak and will be influenced by multiple factors not measured here.

Biologists reported a higher level of knowledge, a higher level of concern about climate change and a greater awareness of the effects of climate change but this is to be expected as they are studying courses that include the subject. Further analysis between gender and course studied showed that there were differences between these groups as all those who answered the first questionnaire was split into four groups by gender and both the knowledge and awareness score and the overall emotion score was significantly different.

There is also a lack of general knowledge from all students about climate change, the reasons for it, what is causing it, what greenhouse gases are and what the effects of climate change are so although the perception is that they do

know about climate change all students do not know as much as they think they do.

When exploring the change between the students who completed both the pre and the post questionnaire there were significant increases in self-reported climate change knowledge, levels of worry and reported changes in actions increasing. It must be acknowledged that reported increased changes in positive action could be due to social desirability bias and also that although the intention may be there it has not actually happened yet (Kollmuss and Agyeman, 2002; Whitmarsh, 2009).

6.0 Qualitative Results

6.1 Background

One focus group was conducted with three students and generated very interesting, exciting debate about climate change. All three students were very interested in climate change and were enthusiastic about doing something themselves. They were not put off by the subject being so encompassing and interdisciplinary or that there were limited positive outcomes moving forward but they still felt that something could be done about it and in fact, starting small felt achievable rather than trying to get the big things, like global legislation resolved. The three respondents interviewed in the focus group were all first-year students and female. Student 1 was an older first-year student, aged 28 studying BSc Animal Biology while Student 2 was aged 18 years old and studying BSc Biological Sciences and Student 3 was also 18 and studying BSc Sociology.

A further four in-depth one to one interviews were conducted with two of the focus group respondents (Students 1 and 2 – who were then second year students) and also with two third year students who had also done some work around climate change and were happy to talk about their experiences. Student 4 was female, aged 20 and studying BSc Animal Biology and Student 5 was also female, aged 20 and studying BSc Sociology. These interviews were different as the students had had more time to think about climate change and

the themes explored were deeper in that they were looking at long term change, whether they had crossed a threshold and changed their actions and what their future actions were going to be.

6.2 Emotional Aspects

All respondents who took part in the focus groups and the face-to-face interviews were asked what they thought of when they were asked about 'climate change'. The key thoughts were:-

- Global warming
- Seas rising
- Certain species dying
- Deforestation

> *'It's quite overwhelming to think about the potential that it could have to impact on the planet. Things like that xxx was saying about the sea level rise, how the maximum potential is actually a lot higher than the IPCC publishes…….. thinking about countries like the Maldives that could essentially be wiped out by it in a matter of decades' (Student 4)*

Respondents were also asked about their emotions and what they felt when thinking about climate change, the main ones being:-

- Sadness
- Curious/ intrigued
- Anger
- Worry
- More needs to be done to convince people to do otherwise
- Scared
- Makes me want to do something about it
- Why are people apathetic?

> *'I felt passionate, I felt angry, I felt sad, I felt helpless' (Student 2)*

'I think I'm very worried to be honest……I think it has got larger especially when I moved here and I realised that people don't care about anything around you.' (Student 5)

'Frustrated and angry at...I feel frustrated at people and angry at companies that they don't take responsibility they just think of the profits.' (Student 5)

'I think it's really scary. It's quite overwhelming to think about the potential that it could have to impact on the planet. Things like…….the sea level rise, how the maximum potential is actually a lot higher than the IPCC publishes just because they have to be so conservative about it, I think that's quite scary. ….. Sad that people don't want to...sad and confused that people don't think it impacts on their life.' (Student 1)

When asked about their emotions and thoughts most said that they felt very strongly about climate change, that it was a reality, there was a feeling of helplessness and that they found it hard to talk about it to others.

'I felt helpless in the sense that I wanted to do something about it but I didn't really know how I could do it on my own. And it's kind of hard because you do try and do bits and you do try and speak to people, but they never take you seriously enough'. (Student 2)

6.3 Other people's thoughts

Often when respondents were speaking to others who were not biology students but were in a different school, friends or people that they met felt that they were not being taken seriously but were perceived as being socially unacceptable.

'You get called like a 'hippie' if you even mention climate change which is really frustrating. People I don't know they seem to not...they don't want to know about it' (Student 4)

Respondents also stated that people just did not want to engage with something that they did not understand or that they felt was too confusing or possibly not something that concerned them this could be because of their subject area at university…

> ….. *'especially compared to other students who don't study biology I think there's a huge difference there. I think other students just have no idea and kind of don't want to know as well. (Student 4)*

Another reason given was that some people thought it was a conspiracy theory or just did not want to know and were unlikely to change their behaviour when climate change is brought up or discussed….

> *'…. I have a friend, who thinks it's all a big conspiracy theory……and my flatmate who studies in the business school and she just made a joke saying 'oh and I'll still be at home taking my half hour shower' and kind of laughed it off.' (Student 4)*

While another view about the lack of action or even thought about climate change was because….

> *'I get the feeling that if they don't understand it they don't really want to. I think they find it a bit scary and just think if they ignore it it's not going to happen to them and it's somebody else's problem. Yeah, that's the main thing actually they think other people will deal with it and it's not their problem.' (Student 3)*

One of the respondents was quite philosophical about changing people's views and opinions…

> *'But the change starts within yourself and you can't just make everybody change their mind.' (Student 2)*

While another said that it took her a long time to make her partner change his views…

'It's taken about two years at least and I think you need to be very consistent, explain your actions why you're exactly doing it because I think he was very sceptical about climate change and different food and where it comes from an everything because he has never grown carrots or everything outside, and I think when he actually realised that it takes a couple of months to grown one carrot he appreciates everything much more. I think it's just the general knowledge and education I guess but it has to be forced because I've been forcing it for two years.' (Student 5)

There was also anecdotal evidence that partner's or friends of the respondents had been influenced by their changes in ideas and/ or behaviour.

'He (partner) is actually self-employed and there are two younger guys who work there……. recently when they are having lunch he's even telling them when they're having a burger from McDonald's and he's telling them do you know where it comes from, so I think it's really good.' (Student 5)

Other respondents also mentioned that they had seen a change in their friends due to discussing climate change and also changing behaviour as they will follow.

'Yeah, my flatmates definitely have and most of my friends have started doing more recycling and food recycling…….I think she's learning more about it. Suppose the knowing that they're not on their own and that there's other people doing it too and it's not uncool to recycle….Yeah and because it's not that hard to recycle…....you can still be lazy and still recycle.' (Student 2)

6.4 Learning about climate change

None of the respondents felt that they had learnt a lot about climate change at school or elsewhere prior to starting university.

'I don't think I was ever really taught it in school at all, it was never a huge part, I don't remember it...' (Student 4)

'Learnt about recycling etc but not about the world ending or all the other possible scenarios' (Student 2)

Climate change was something that most people felt had been going on around them and they picked things up from their parents or from other sources.

'Not about climate change no. We'd briefly spoken about it (at school) *and done little bits of recycling here and there, my mum was always big on recycling but it was never really something that people did wholeheartedly I think.' (Student 2)*

'I think my family's always been quite environmentally aware, always been quite strict on things like recycling and eco-living kind of thing. Our home is sort of very friendly, really thick insulation and in-ground source heat pump things like that. So yeah, I think I was raised in an environment and that was always part of my lifestyle.' (Student 4)

'I think it's just everyday life…….probably started learning when I was about ten maybe earlier. My first knowledge was probably from documentaries and then from school.' (Student 5)

'Yeah, it's always been part of my life'. (Student 4)

6.5 External Factors

It is interesting to note that all the respondents apart from one had grown up in a rural environment and they all mentioned that this was definitely a factor for them as they felt that they had a strong relationship with nature and the countryside and were used to seeing the seasons changing whereas those in a city might not have such a symbiotic relationship.

'I think it may be because my early years were spent in the countryside. Because a big city kind of swallows you and you can't see the seasons. You can feel the temperature changing but you can't see nature and what's going on there. Maybe you stop caring because you can't see it.'

'….a lot of people are trapped in a city, surrounded by smog and cars and people and they never really get to see the real nature of it and maybe that's what makes them not appreciate stopping global warming'. (Student 2)

'I was brought up in the countryside, my closest neighbour was 5 miles or 6 miles away. Our school where we went it was between two nature reserves and we had extra lessons on surviving in the wild, what plants you can eat, stuff that you can't learn anywhere else' (Student 4)

On the other hand, one respondent did also talk about the stronger role of the Church where she grew up in a rural community where climate change and environmental issues were not considered.

'*I know a lot of people who have grown up in the countryside but they're not educated and they call people like me eco-freaks…… they can do whatever they want because they own the planet. Maybe it's a religious thing as well because for some people we are better than animals, nature, that's what God said so we can, should do whatever we want.' (Student 1)*

There were other mentions of the role that religion took in the climate change debate and that because of the debate of evolution versus creationism that this was also a problem in getting the climate change message through.

‘And I think it's a lot to do with people's personal beliefs as well because they believe more in God or whatever and I don't know, just it's a culture.’ (Student 3)

6.6 Engaging with Climate Change

There was a feeling that the method of learning and how much was learnt depended on the student, some students would only learn for exams while some would become more involved and learn in-depth there would be some that fell between these two levels.

> *'Because it really depends on the person, they learn about this right. And then there's a lot of people who learn but they don't know why they do it and it's not only with climate change, it's with everything. So, it's really difficult for teachers actually to explain everything and make people want to know more or understand it better. To be honest most people are like yeah, just learn about it, pass the test and go home and...so I don't really know. (Student 1)*

There was also a level of disbelief that some students would be taught about climate change and even write essays or exams on the subject but would not alter their behaviour.

> *'We had ethical analysis which was about climate change, but I don't think a lot of people took it as such to be honest…….. had to write an ethical analysis but they were concentrating or not, I don't know…….they weren't really thinking about it…….. there's so many students I've spoken to they don't do recycling, they don't do anything and I'm just like, why do you just write about something if you don't do anything?' (Student 5)*

When asked about how their views had changed since they had received more information about climate change in their lectures and two main views came through from the interviews, firstly

> *'There wasn't a change in my views about things but it made me think about it in a different way, finding out about different things……. So I started looking for information on different government websites and things like this.' (Student 1)*

While others were much more enlightened by the information that they were given around climate change and were inspired to change their behaviour and to do something different.

> *'There was some parts which struck me about how bad global warming had got, there were some facts and figures he told me about which I can't actually remember now, but when we were there I was struck by it and I suppose that kind of made me think, I need to make more of a point of doing things and I don't know, I started doing more towards it to happen.' (Student 2)*

There was a disparity in the level of climate change awareness depending in which school of the University that students attended.

> '*I think I've actually noticed a big difference between different students in different schools of the university. Especially with things like the business school they seem to be very economics focused and they just seem to think that that's all that matters and anything else is just too petty and isn't worth dealing with.' (Student 4)*

6.7 How to Teach Climate Change

Ideas on how best to engage students and to keep them interested in climate change was debated and these included:-

> '*I think if they know it's going to be fun and interactive then they'll be more interested' (Student 2)*

> *'… if you can put it onto your CV that you've been in the xxx group or whatever it is and you can put it on your CV and that really motivated people as well because they know it's going to benefit them. So, I suppose if you did that for people then that might make them more interested as well to come along to the group, and when they got to the group they would realise that it's actually quite good'. (Student 3)*

Other ideas were to have smaller groups of people 120 students in one room was considered to be too many for any meaningful debate or learning to take place.

> *'It would be good to work on projects in small groups. Instead of big lectures, something smaller that everyone is engaged in doing something……I think around 30 people so you can work in groups and it's not going to cause chaos would be good……..Ask them about their opinion but not in writing but trying to get them to start discussing things. So they have to say something aloud. I think sometimes saying something aloud and hearing it not only in your head, then your views can change a lot, so basically trying to engage them in discussion I think is very important.' (Student 1)*

Other things that were mentioned were media/ message boards where students could post messages and debate about climate change.

> *If it's one a week……..even just a few sentences about what you think and why you think it's yes or no or, just to make them think at least, not just going home and leaving all the work for later, just to have a little bit to read and make up your mind, yeah I think it's good.' (Student 1)*

> *'People need that someone to keep pushing them on, kind of like a group leader. Once they do then it keeps jogging their memory, makes them stay on to it. Yeah, I think that would work if people got into a group and onto a message board.' (Student 2)*

> Other ideas that were discussed included increased interaction, being talked at was not considered to be the best method for learning but alternatives did increase the length of time that it was remembered.

> *'I like interaction. A lot of people hate to be asked questions and stuff because it puts them on edge and whether they'll get it right or anything but if you speak to them it makes them think more about it so it makes them stay in their brain more.' (Student 2)*

Other areas covered including quizzes using a ‘clicker’, photographs showing the before and after and project based work.

> ‘*….the clicky thing, they're good because it makes you think about it more.’ (Student 2)*

> *‘Group work and seeing effects, like seeing things as they're actually happening is a really good way, like getting out there and doing it. Like photos of before and after and that. That's good because it shows people a difference.’ (Student 3)*

There was consensus that all undergraduates should be taught about climate change, whether this was a compulsory module for all or it was taught in the context of their course and/ or specialism.

> *‘Obviously people who aren’t doing environmental related courses probably wouldn't have as much interest in it…….if you overwhelm them with too much stuff they're just going to block it out and think why are we doing this, this is irrelevant to me and not pay attention to it. So I think just subtly incorporating it into things like say for example with architecture you could stress how important it is to build eco-friendly buildings, with business they could do a module on building a sustainable company.’ (Student 4)*

> *‘I think it should be used more in biology degrees and whatever because I think a lot of people, they have a chance, there's so many students I've spoken to they don't do recycling, they don't do anything and I'm just like, why do you just write about something if you don't do anything? It's, yeah.’ (Student 5)*

Another important factor that was mentioned was the lecturer themselves, having a teacher who was passionate and enthusiastic about the subject and who made the lecture both interesting and engaging were difficult to find and could be the reason why some students are so enthused about the subject matter.

'xxxx is amazing, so his lectures made me think about digging more, getting more information about things. So I can't see what else he could do better' (Student 3)

6.8 Future Teaching

When to start teaching climate change was discussed at length and there was a general consensus that Primary School children should be taught about climate change.

'You'd have to put it in primary school' (Student 5)

'The main thing that came up as part of my report was the lack of children's education and I think that would be really important……..like I said I don't think it was even mentioned in primary school at all, if it was it wasn't stressed at all as anything important. I think that would be a major thing making a difference.' (Student 4)

'It should definitely start in primary school when they're young. Things like outdoor activities that kind of connect people to nature.' (Student 3)

There was no real feeling that children in Primary were too young and psychologically vulnerable to be taught about climate change but instead a more positive view that children were strong enough to understand it and to do something about it. References were made the similarities to dinosaurs and how all children are aware that they were died out.

'Everybody's taught right and wrong from a young age aren't they, and that's right and wrong. I don't know, what primary in are they in by the age of about 7. I think by the age of 7……..I think that's fair enough age. You learn about the dinosaurs...' (Student 2)

That's true actually. My son's five, and he's completely happy that a big meteorite landed on the earth and killed them. (Moderator)

'*Yeah, so if they're able to take that on and they'll be more interested in.....kids love to be able to help people to do anything important and*

stuff so if they can go home and be like "I learnt this today, and it's happening now" and I can do this towards it. And mummy and daddy we have to do this". I think they'll accept it and will actually rally to it. (Student 2)

All the respondents had felt that they did not know enough about climate change and still felt that there was a lot to learn so that the earlier children were taught the better it would be for them and the planet.

Additionally, there was a thought that people living in cities were disassociating themselves with nature and as a result also climate change and they should be taught how to re-connect or to connect for the first time.

'…just kind of reconnecting people with nature because I think we live in such a built up, modernised world that people become so absorbed in day to day city life and things that shouldn't really matter as a species. I don't know it's like we've disconnected ourselves with any other aspects of nature, like any other animals or any plants or anything, we think we're like this exclusive species, we can do what we want and the world's ours to use and abuse. I think just reconnecting people with nature and reminding them that they're part of the earth eco-system and they have a responsible part to play in that.' (Student 4)

6.9 Media

It was felt that the media had a role in how to change how people felt and thought about climate change. One respondent mentioned how a lot of people *'just think that climate change is just media stuff.'*

There was some discussion around the role the media played in the USA as respondents mentioned that there was even more climate change denial in the media than in the UK.

'I think in America it's maybe even more in the media that there is no climate change happening, it's even more in the media there than here.' (Student 5)

There was also some discussion about the role that climate change deniers had in the media with the view that climate change deniers should not be given equal time or awarded the same authority on television or radio that climate change experts were given.

> *'Climate change should only be discussed on TV or radio by people who know what they are talking about. Not by people who have no idea about the subject.' (Student 3)*

There was also a discussion around smoking and how legislation and the media have made smoking an almost taboo habit, as it not advertised on TV, there are no real smokers on television and even with legislation making it illegal to smoke in most places there has been a real shift in public perception towards smoking.

> '*Look at smoking and what the smoking ban has done, no one really smokes anymore, it's too expensive and you have to go outside and get cold and wet to have a fag.' (Student 3)*

6.10 Legislation

Two respondents mentioned using legislation and regulation as a way of combatting climate change. One felt that there was no connection between the environment and people's behaviour and discussed the way that schools engaged with the environment.

> *'Maybe schools do a little clean up on the beach and this is kind of almost mandatory so the school have a good name or something, but it's not really something that people would like to do themselves, it almost seems like it has to be regulated here to work because people are not really connected with it.' (Student 3)*

This again links in with the dissociation of people living in the city compared to those living in the country and/ or in small communities.

The same respondent also mentioned that Governments are perceived to be not legislating or legislating strongly enough because…

> '……*big companies just rule the world. The thing is that even some laws can't go against them and governments don't want to make laws against them because otherwise they might lose trade or whatever, so I think it's quite a big issue.' (Student 5)*

She was also unsure whether these small changes were going to make much difference and that the only effective change was for Governments to change the system and to possibly force people to change.

> *'…..but I don't think small changes really make any difference…...you just have to change all the system that the government works with, all the laws…….I don't think people would change unless they were really forced' (Student 5)*

The other respondent felt that recycling should be made compulsory as in other cities or countries…

> *'I think making recycling compulsory. I stayed in Boston for a while and with their rubbish they have to put it out on the street in clear plastic bags and if anything recyclable is in the main trash then they get fined for it and I think that would be a really good idea.' (Student 4)*

Other legislation included paying slightly more for plastic bottles, glass bottles and cans which would amount to 5p or 10p extra per item and this would then be refunded when they were returned. The respondent said that this legislation had worked very effectively in her home country and could be an efficient method of increasing recycling.

> *'after that there wasn't any plastic on the streets, any bottles at all' (Student 5)*

Current legislation in the UK was not felt to be strong enough and that politicians need to be more educated on what is happening with climate change

and also what will happen in the future if changes are not met and what they will have to do in order to meet the targets that the UK Government have signed up to.

> *'politicians have to be more educated because I think a lot of their speeches are made up by other people and then read over and then maybe criticised……I don't think they're on track with that* (meeting CO_2 targets for 2050) *though…….So they can say big words but I don't think they're doing that stuff. Then maybe if it comes to 2050 and then they are not on track and then they can just say look other countries didn't do it either so it's not that bad, maybe we did more than France or Germany so yeah. I think they're going to kind of follow into it.' (Student 5)*

6.11 Actions to take

All respondents felt strongly that a lot more could be done to reduce the effects of climate change. Some of the ideas were quite militant and reactionary and showed how important the respondents felt that something more needed to be done. There was generally a feeling that the following actions should be taken.

1. Make recycling compulsory

   > *'I stayed in Boston for a while and with their rubbish they have to put it out on the street in clear plastic bags and if anything recyclable is in the main trash then they get fined for it and I think that would be a really good idea' (Student 4)*

2. Improving door step recycling collections

   > *'We have one general waste bin and one recycling bin and all the recyclables go in the recycling bin and they go out alternate weeks and that makes it so much easier and I think that would definitely encourage people to recycle more, it's more simple.' (Student 3)*

3. Empty household bins every fortnight rather than once a week

> *'Because we have the big buckets, they got emptied every week and I was like why? We don't have so much waste, emptied every single week and…you can empty the bucket only once a month and it works and it's not even full.' (Student 5)*

4. Growing own veggies/ fruit etc and/ or using farm shops

> *'Because we have a really, really small back garden but I'm still like...maybe it's because of my background, my family or something but I grow my own vegetables as much as I can, all the herbs…' (Student 5)*

> *'now he goes to a farm shop or a local shop where you can see actually the chickens running around.' (Student 5)*

5. More ethical recycling

> *'I went for a really nice walk in East Lothian and there's a car park there and there was suddenly two fridge freezers there and I was thinking the recycling centre is just half a mile away, why would you rather dump your fridge freezer in a car park in a really nice place rather than in the recycling centre, it doesn't make sense.' (Student 3)*

6. Getting more and different bins for recycling

> *'We should get more bins so that we can recycle more different things'. (Student 3)*

7. Reduce packaging and plastic bags (charging for plastic bags has now come into effect as of the 20th October 2014 (Scottish Ministers, 2014))

> *'I hate it in the shops when they say, for example you buy a bunch of bananas and I don't put it in the plastic bag because I don't think it has to be in the plastic bag and then they put it in the plastic bag at the till and I'm like I don't need the plastic bag, I have my own shopping bag.' (Student 5)*

> *'Also I just saw on the news about the bags of the shops that now they're going to change, but not in here because the Scottish*

government is still looking at whether it works in other parts of the UK.' (Student 5)

'I always take bags for life.' (Student 4)

8. Composting

'I even bought the recycling bucket where you can put all your garden waste and all your peelings and everything so you can make like compost' (Student 2)

9. Local groups at university and elsewhere that could meet to discuss Climate Change and what can be done

'I do like the global warming stuff. So people do need that and like the encouragement of like yeah you should go because....I think if they know it's going to be fun and interactive then they'll be more interested …….. like when we did the planting, we're buying lots of plants and stuff and collecting money from the students from the plants outside… she said you can put it onto your CV that you've been in the plant group……and that really motivated people as well because they know it's going to benefit them.' (Student 2)

10. Lobbying councils to make recycling easier

'Back home it's really good because we have one general waste bin and one recycling bin and all the recyclables go in the recycling bin and they go out alternate weeks and that makes it so much easier and I think that would definitely encourage people to recycle more, it's more simple.' (Student 4)

11. Splitting out the Council Tax Bills to show how much is spent on recycling compared to landfill or waste

'Council Tax pays for everything, they should be kind of written down into a different place what you actually pay for waste, and you would know how much you would actually pay for your waste……then you would be more aware of what you're actually paying for because.....what's the point of buying something in the shop for quite a lot of money and then just throwing half of it in the bin and then just paying for it again.' (Student 5)

12. Cycling more or getting buses everywhere

> *'Cycling is a cheap and easy way to get around, we should all do it at least once a week. Especially here.' (Student 3)*

> *'I just get on my bike and go everywhere on it, it's much easier than getting the bus.' (Student 1)*

13. Less driving and flying

> *'There is no real excuse for getting in the car when you can cycle.' (Student 1)*

> *'It's difficult to justify flying sometimes but we do have to fly sometimes so I try to offset it as much as possible.' (Student 3)*

14. Possibly consider a vegetarian lifestyle or have one veggie day a week

> *'I am a veggie already and it would make a difference if everyone had a meat free Monday or another day every week.' (Student 1)*

15. To make changes in the chemicals and other cleaning solutions that are used

> *'I came up with some ideas on how to save things, so small things for example for cleaning the flat I use only soda and vinegar so I don't buy a lot of different things and it's enough for cleaning everything really well. So I'm trying to come up with some small things that I can improve, I use for example soap nuts for washing.' (Student 1)*

16. Build zero carbon and/ or energy efficient houses that cost virtually nothing to heat

> *'People would rather buy a new house which is energy efficient, and now there is quite a big market for energy efficient houses because then you don't have to pay for electricity but your house is the same cost so you would win so much in the long term.' (Student 5)*

> *'Our house is really eco-friendly, we had it renovated recently with the ground source heat pump, triple glazed windows like three times the recommended insulation and things like that so we've*

got a really eco-friendly house at home. And that's great because you really notice a difference in the bills' (Student 4)

17. Collective movements where people can join and do something in the community or in larger groups that will benefit everyone

    'there was a movement called 'Let's Do It' and it's basically like a civil movement where people just organise, just normal people not organisations, organise a clean-up in the spring because the Baltic Sea is very polluted….. there is so much rubbish……. people are really interested in getting it sorted, so me and my friends decided to take part in this movement and we got everybody involved, everybody's parents, everybody. On 1st May 2006 there was about almost half our population in Estonia all outside cleaning and getting the rubbish together…….now it's every year. Now they have even moved it to India and all these different countries as well, and I think it's good.' (Student 5)

18. Ensure that the media has a consistent message

    'The media needs to be consistent with their message and not allow climate change deniers on the TV. (Student 3)'

6.12 Summary of Qualitative Results

The qualitative analysis was analysed into themes with some clear messages coming through. Students still felt that it was an emotional subject and that it often left them feeling helpless, frustrated and angry. They often found that it could be hard to talk to people who did not feel the same way and that it was difficult to change other people's behaviour but that it could be done.

All student's felt that they had not been taught about climate change much before this point but had always had role models at home that taught them to appreciate that recycling was important and had grown up being environmentally engaged. This links into growing up in a green environment and being able to engage with nature which people from cities find much harder to do so (Chawla and Cushing, 2007).

Engaging with climate change was discussed and there was a level of disbelief that some students would not engage or would learn about the subject but not change their actions or beliefs. It was also noted that students from other faculties did not have the same level of empathy towards climate change. Teaching climate change should be engaging, interactive, participatory and taught to all undergraduates regardless of discipline and should start being taught to primary school pupils.

The media needed to change their way of reporting on climate change and stop having debates that included climate change deniers while governments need to legislate and regulate to promote climate friendly policies. The final theme was around what they could do themselves and these ranged from more recycling, less flying, more cycling and growing vegetables and composting.

The aims of exploring how the emotions and knowledge changed were met as from the qualitative interviews it was felt that although they had various levels of knowledge and understanding around climate change the lecture had both increased their levels of emotion and knowledge. Although there were some feelings of helplessness etc there were also more emotions such as getting others to change behaviour and there was a marked increase in environmentally responsible behaviour.

6.13 Qualitative findings in relation to the aims and objectives

The overall knowledge of the students in the focus groups and interviews was generally high but the interviews were conducted after the climate change lecture, they understood the concepts and the reasons why climate change was happening but expressed concern and frustration about the lack of action by others.

Prior to the lectures although the students had been taught about some environmental issues such as recycling there had been no real climate change education prior to the lecture that they had at university. They did additionally note that their own behaviour and had changed due to the lecture and they were talking more about the subject and had managed to convince others to change their own behaviour.

They students did mention that there were differences between students who studied biology and those who studies other subjects like business studies for example. Other students did not seem to be engaged by the subject of climate change and possibly felt that it did not affect them. It should be noted that although the students felt that biology students were different and more engaged – in many cases this was not the case.

All the students interviewed were female and the reasons around why men did not engage with the subject was not really discussed, although they all felt that education or course studied was more important than gender when engaging with environmental issues.

7.0 Discussion & Conclusions

7.1 Discussion

The data from the quantitative questionnaires shows that knowledge levels before the climate change lectures were low, with many students unaware of basic climate change facts. Whilst there was evidence that knowledge levels increased after the lecture, there were still some who did show low levels of knowledge but this could be because they did not attend the climate lecture rather than a sign of disengagement or a perception that they still did not know much about the subject matter (Poortinga *et al.*, 2011).

This apparent low level of climate change knowledge for first year undergraduates challenges the suggestion that students might be bored with climate change, having heard or been taught it all before (Robinson, 2012). This was upheld in the qualitative stage as students felt that they had not been taught about climate change in depth prior to university and they felt that they should have been. Many students would not have been taught about climate change since primary school and even though they may have been taught in secondary education this would still have been several years away and climate change science will have moved forward in this time.

There was a real feeling from the qualitative data that all students, whatever discipline, should be taught about climate change together with some subject specific link e.g. engineering or the built environment could have sustainable or zero carbon building, or in social studies, media studies etc the idea of using nuclear energy in the future rather than fossil fuels and how to change public perceptions (Wise, 2010; Lynas, 2013). Science is always changing and moving forwards and climate change education should be taught without teachers worrying about repeating information or that they are possibly boring students, particularly as student's misconceptions about climate change can be alarming (Rebich and Gautier, 2005; Theissen, 2011). This was also shown in the quantitative data by the number of students who incorrectly ticked innocuous gases thinking that they were greenhouse gases or the misconceptions that many students showed when asked about the causes of climate change (Gautier, Deutsch and Rebich, 2006). There are barriers to teaching climate change to everyone such as teachers not feeling comfortable about teaching a difficult subject that does not have much hope, or that they feel they do not know enough about the subject to teach it, difficulties fitting in more lectures, multi-disciplinary issues, having to teach a subject that on the face of it does not have a relationship with climate change such as business studies but just needs to be taught using an environmental twist (Dawe, Taylor and Fuller, 2003; Wise, 2010)

There was no real evidence that students were cynical or disengaged apart from a few lone dissenters in the quantitative stage as a small minority said that they were not worried, concerned, were non-committal or said that climate change was not true. However, there is evidence that *'"the more information a person has about global warming, the less responsible he or she feels for it; and indirectly, the more information a person has about global warming, the less concerned he or she is for it."* (Kellstedt, Zahran and Vedlitz, 2008) which might explain why there are some students who were unconcerned but who also self-reported high levels of knowledge on the subject.

The vast majority of students were engaged as nearly three-quarters said that 'more needs to be done'. This was backed with the findings from the qualitative phase as the students interviewed were very engaged and switched on with the

subject, however they all talked about problems that they had when talking to other students or friends about climate change. They often felt that others were not interested, or that if they were not studying climate change did not need to think about it and were left feeling isolated (Lorenzoni, Nicholson-Cole and Whitmarsh, 2007). It seems that there is social pressure to conform to models of consumerism that downplay environmental concerns as the interests of 'hippies' (Barr, Gilg and Shaw, 2011). It may be that of those that had changed their own behaviour felt that the environmental issues were enough for them to want to change whilst those who were still thinking about it or had not changed behaviour may need an incentive or a self-interest for them to change so that more needs to be done to engage with them maybe by governments, society generally making it normal for thinking and acting sustainably (Bamberg and Möser, 2007; Nigbur, Lyons and David, 2010).

Generally, there was an increase in negative emotions and feelings after the climate change lectures with feelings of helplessness, powerless, scared, anger and frustration all increasing. This combined with some students showing a lack of knowledge and understanding about climate change both before and after the lectures suggest that some find it too complicated to understand and they either do not engage and try to understand it or put up a barrier to learning. Hence the suggestion that climate change is a threshold subject (Land and Meyer, 2006; Perkins, 2006) may be supported here, with such subjects expected to be emotionally troublesome. However, there are many other ways in which these findings could be interpreted. A fuller exploration of this in the focus groups would have helped, but the self-selected nature of these which led to attendance by only a few enthusiastic and well informed students made this difficult.

The broad concept of learning was discussed in the qualitative phase and the students who took part were enthusiastic and engaged in the subject matter but they did think that the lessons should be fun and ideas mentioned included group work with a theme over a period of time, message boards that people have to contribute to, quizzes using the '*clicky thing'* (Ereaut and Segnit, 2006). Trying to stay away from the traditional way of teaching but also imparting a clear message and teaching with the aim of deep learning through using

technology or ‘interactive windows’ (Huxham, 2005). Although not mentioned by the respondents teaching in a different environment, such as outdoors, can be a memorable way of engaging with students and encouraging increased or deeper learning (Nicol, 2013; Scott, Boyd and Colquhoun, 2013).

Using different approaches to teaching could help those students who are finding climate change too emotional, uncertain and complicated as subject to engage with fully enough to ensure deep learning. Many people will just hold back if they feel that the subject matter is too emotional for them (Norgaard, 2006). There are different options for this such as using small bite size pieces of information, working in a facilitative way, timing time to understand difficult concepts and encouraging emotional resilience to overcome the emotional side of climate change learning and to encourage deep learning (Knight, 2006; Land and Meyer, 2006; G. Cousin, 2010; Hall, 2012).

Exploring how attitudes and knowledge changed from pre to post climate change lectures in the quantitative data there is a definite shift with most students learning more, most feeling more worried but they are also saying that something needs to be done e.g. reducing carbon dioxide emissions, education for all around climate change, recycling or global legislation all being picked.

Students also said that they have already changed their behaviours and/ or will do so in the future (74% had already or were going to make at least one change in their behaviour). Therefore, from these results, although from a small cohort and only using self-reported data, it would seem that any climate change education even a small amount will be beneficial to all.

The quantitative data also showed that even before having any climate change education everyone does know something about the subject and for those that do not study sciences can still understand and retain information about the subject. Although it must be noted that male students felt more confident about climate change but it is felt that they overreported their knowledge at the pre stage (Goldberg *et al.*, 1977; Bleidorn *et al.*, 2016) but actual knowledge reported around climate change, greenhouse gases were very similar between male and female students (McCright, 2010). So, there may be an argument for

taking this perceived knowledge or lack of knowledge into account when teaching and additionally people can think that they know all about climate change having watched reports on the news or elsewhere so additional teaching would be beneficial for change

Changing the general perception of the public towards climate change could be achieved through education if everyone started to adopt carbon neutral behaviours or even put pressure onto governments and local authorities that would also start to alleviate the stigma or taboo around being a “hippie” and this also ties in with engaging with nature and living in greener spaces (Zerubavel, 2006). Institutional barriers are often reasons why people do not behave environmentally responsibly and this could be because of lack of facilities, poor communication, lack of a coherent policy etc (Wolf, 2011). Public pressure on Councils and Government could lead to strengthening legislation around recycling and sustainable behaviour would help reduce any stigmas or taboos (Hoffman, 2010; Menegaki, 2012).

The main areas that the students thought could be improved upon were around education and taking small steps to ensure that something is done. Although there was some discussion of changing legislation and other more systemic approaches there was relatively little focus on changing national and international policy. From the comments and thoughts from the respondents it is hard to identify collective routes to protest or even action when this is palpably needed. There was one mention of some kind of activism but it was fairly weak and even then more of an admission that there was no point trying to lobby Government as they were all controlled by big corporations or that their latest climate change targets and legislation was already going to fail (Moser and Orld, 2009).

Although protesting and action are traditionally considered to be a part of student life, at the time the interviews were conducted activism was not as prevalent. There may be many reasons for this but changes in government legislation partly to combat terrorism and partly to stop violent protests and riots have made it harder to organise legal protests through the Terrorism Act 2006 (Stationary Office, 2006). Another reason that protesting may be considered to

be ineffectual are the well-attended anti-war protests that took place in all over the UK before the UK invaded Afghanistan in October 2003 (BBC, 2003; Murray *et al.*, 2008) and even the G8 protests that took place in Edinburgh in 2005 (The Guardian, 2005; Gorringe and Michael, 2008) were perceived by many to be ignored by the Government but may be a reason why the respondents were not actively lobbying or protesting to change global or even UK legislation on the larger issues such as meeting CO_2 reduction limits, but are more focused on taking small steps such as getting more recycling bins or by halving the number of collections in order to save money or to be 'greener' (Mason, 2009).

Many of the points that were raised in the groups and interviews were apolitical and were mostly about changing their own lifestyle choices like recycling. However, given the scale of the global problem facing the world such lifestyle changes will not be big enough to address the problem. It may be that people feel so powerless that they cannot take on larger organisations or Governments but that small steps will make some sort of difference. This could point towards an increasingly individualistic society who do not want to be or who do not feel part of a larger community (Swim *et al.*, 2009). However, since the interviews were conducted there has been growing unrest in the UK with 'anti-austerity' marches and protests taking place since the Conservative Government won the general election in May 2015 (BBC, 2015; Metropolitan Police, 2015). Activism seems to be increasing with an ever stronger presence from climate change campaigners such as 350.org who are organising events globally and anti-austerity campaigners like the People's Assembly who are working in the UK and it is possible that the respondents in the qualitative phase would have answered differently if talked to now.

It is worth noting that all respondents in the qualitative phase apart from one had grown up in the countryside so were familiar with a community and/ or rural way of life. They mentioned that there is more accountability in an area where everyone knows you and where people tend to look after their local area and common spaces. All respondents now lived in the city and thought that maybe this is why people they feel so disconnected with their environment as they are surrounded by people who do not seem to care for their surroundings. However, research in Australia revealed that it did not matter whether people

lived in an urban or rural environment but that other issues such as trust in the information given about climate change, their own knowledge and where they lived was the most important issues (Boon, 2016)

All respondents who had had a rural upbringing thought that being connected with nature was crucial, in the countryside they were all in touch with the seasons and how things were changing over time but now changed having moved to the City where the connectedness with nature and the seasons is not so noticeable. This might be another reason why the respondents are finding it difficult to connect with like-minded people. There does seem to be a dissociation with what is happening with climate change and for those who live in areas where there are no real parks, nature conserves or who have their own garden and their views on climate change. Respondents mentioned re-connecting with nature by going wild camping or by just going for walks in the park and this is something that people of all ages could do not just students. Other ideas were to make more space or allotments or to make people engage by growing their own fruit and vegetables with the idea that if you knew it took a couple of months to grow a carrot you would appreciate it more.

The media needs to have a clear and consistent voice and this is difficult to police but needs to be done somehow so that people do think that there is no debate about whether or not climate change is real. There was not a discussion about legislating the media but this might be a way forward so that there is no spurious debate about the fundamentals of climate change – the facts are that it is happening the only debate should be how drastically do things have to change in order to try and alleviate it.

Resilience was also discussed in depth and it was clear that the respondents felt that climate change should be taught at a much lower level and that it was such an important subject it should be taught to everyone. Using the dinosaur analogy was excellent as this clearly shows that very young children – 5 and onwards – can grasp a very complicated and sad subject with no positive outcome and learn about it, assimilate the information and move on. Using this concept there is no reason why the difficult subject of climate change cannot also be taught honestly and with the real message that something needs to be

done rather than ending on a positive note that it might be OK or that technology will fix everything with geoengineering. It has already been mentioned that all university students should be taught about climate change but this should be done at a much early stage such a primary school for possibly 7 year olds and then continued throughout everyone's educational life.

A core motivation for the current work was to explore the relationship between emotional and cognitive responses to climate change education. Given the depressing outlook and the large body of work showing a range of forms of denial in response to bad news, it is likely that emotional responses will interfere with and perhaps prevent learning for some students, so it is possible that a student could just disengage with the subject (Cousin, 2006; Klein, 2013). However, there was no evidence in the current data of negative relationship between learning and negative emotions; changes in knowledge and emotional response were positively related, albeit only weakly. And the qualitative data showed that students were ready to learn about this difficult subject and felt it was important for everyone, they also discussed how teaching should be engaging, participatory, inclusive and using different media to increase learning. Climate change is a quintessentially complex and multi-disciplinary subject, which involves emotional as well as cognitive challenge. But the principles of active learning, deep learning and social constructivist approaches to learning are all relevant here and the existing literature already emphasises the important emotional dimensions of learning. These pedagogies acknowledge that learning needs supportive environments and has emotional and ethical dimensions; these insights apply equally, and perhaps especially, to climate change.

7.2 Conclusions

To conclude, climate change is a wicked subject and is both worrying and difficult subject to learn and to teach but there are some positives come from the current research. Firstly, that it is possible to teach a difficult subject at a deep level, despite the emotions such as helplessness, anger etc that can often lead to real feelings of grief. Despite the emotional barriers that climate change can raise, it is imperative that students are taught the facts and implications.

Given the emotional responses, it may also be incumbent on educators to teach students how to deal with these emotions and move through them to exploring what can be done to mitigate climate change.

The Government and all media organisations need to work together to put a message out to everyone about the real issues of climate change and to say clearly that anthropogenic climate change is real, it is happening and the debate should focus on how quickly effects are going to happen and what do we need to do about it. Clarifying the public discourse and avoiding misleading information and deliberate denial may allow everyone to feel strongly enough to be able to take action and maybe even ask 'why were we not told this before?' This has happened to some extent with smoking and there is no real reason why this cannot happen with climate change.

Education for all from a young age is also crucial and this can be in many forms from teaching about the science, to just re-connecting with nature and seeing how climate change and global warming is changing the planet. Despite the respondents surveyed here being highly motivated undergraduates, their level of understanding of basic climate change facts was low and many harboured incorrect notions. Hence, there was no evidence that such students have been 'over exposed' to climate change education and the data revealed an understanding of the importance of climate change education and a frustrated hunger for change. If this data is representative then they support the urgent need for more and better climate change education, at all levels, and should reassure teachers that students are not 'saturated' with or bored by the topic. Climate change is real and will affect everyone (Unicef, 2013); in every occupation and in every walk of life and there is no reason why everyone cannot be educated about the subject.

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Appendix 1- Marked Up Questionnaire

Climate Change Questionnaire

Please answer all questions and return back to the researcher.

Q1. How well do you think you understand the issues surrounding climate change? PLEASE USE THE FOLLOWING SCALE WHERE 7 IS EXTREMELY WELL AND 1 IS NOT VERY WELL AT ALL						
1 (-3)	2 (-2)	3 (-1)	4 (0)	5 (+1)	6 (+2)	7 (+3)

Q2. How worried are you, if at all, about the effect of climate change on the planet? PLEASE USE A SCALE OF 1 to 7 WHERE 1 IS NOT AT ALL WORRIED AND 7 IS EXTREMELY WORRIED						
1 (-3)	2 (-2)	3 (-1)	4 (0)	5 (+1)	6 (+2)	7 (+3)

Q3. When you think about what is happening to the world with regard to climate change how or what do you feel? PLEASE TICK THE THREE THAT APPLY TO YOU MOST					
Angry (+1)	☐	Overwhelmed (+1)	☐	Frustrated (+1)	☐
Helpless (+1)	☐	Too much information to take in (+1)	☐	Not concerned about it (-1)	☐
Scared (+1)	☐	Powerless (+1)	☐	Non-committal (0)	☐
Disbelief (-1)	☐	More needs to be done (+1)	☐	It's not true (-1)	☐
Patronised (-1)	☐	It's a good thing (-1)	☐	Don't know enough about it (0)	☐
Other (please specify)_____					

Q4. How important do you feel that climate change and the issues surrounding the potential implications of climate change are? PLEASE USE A SCALE OF 1 – 7 WHERE 1 IS VERY UNIMPORTANT AND 7 IS EXTREMELY IMPORTANT						
1 (-3)	2 (-2)	3 (-1)	4 (0)	5 (+1)	6 (+2)	7 (+3)

Q5. What do you think are the likely effects of climate change over the next century? PLEASE TICK ALL THAT APPLY			
A rise in oceanic pH (-1)	☐	An ice-free arctic ocean, melting glaciers or polar ice caps (+1)	☐
Latitudinal shifts in species' ranges (+1)	☐	Rising sea levels (+1)	☐
Reduced global rainfall (-1)	☐	Don't know (0)	☐
Faster temperature rises in the tropics than at the poles (-1)	☐	Other (please specify)	☐
A global increase in temperature (+1)	☐	None of these (-1)	☐

Q6. Which of the following are greenhouse gases? PLEASE TICK ALL THAT APPLY			
Carbon Dioxide (+1)	☐	Water Vapour (+1)	☐
Methane (+1)	☐	Fluorinated gases (+1)	☐
Sulphur Dioxide (-1)	☐	Don't know (-1)	☐
Hydrogen Sulphide (-1)	☐	Other (please specify) _____	☐

Q7. Increases in global average temperature over the past fifty years have been caused by..? PLEASE TICK ALL THAT APPLY			
Changes in solar radiation (-1)	☐	Long term recovery from the last ice age (-1)	☐
Burning fossil fuels (+1)	☐	Deforestation (+1)	☐
Volcanic eruptions (-1)	☐	Don't know (-1)	☐
Natural variations (-1)	☐	Other (please specify) _____	☐

Q8. What do you think needs to be done about climate change if anything at all? PLEASE TICK ALL THAT APPLY			
Reduce CO_2 emissions (+1)	☐	Global legislation (+1)	☐

More recycling (+1)	☐	Education about climate change for everyone (+1)	☐
Reduce energy consumption (+1)	☐	Nothing (-1)	☐
Renewable sources of energy (+1)	☐	Don't know (-1)	☐
Other (please explain your answer here)			

Q9. How much have your views on climate change changed in the last month or so?

PLEASE USE THE FOLLOWING SCALE WHERE 7 IS A GREAT DEAL AND 1 IS NOT AT ALL

1 (-3)	2 (-2)	3 (-1)	4 (0)	5 (+1)	6 (+2)	7 (+3)

Q10. Do you think that your actions have or will change based on your views on climate change?

PLEASE USE A SCALE OF 1 to 7 WHERE 1 IS WON'T CHANGE AT ALL AND 7 IS WILL CHANGE A GREAT DEAL

1 (-3)	2 (-2)	3 (-1)	4 (0)	5 (+1)	6 (+2)	7 (+3)

Demographics

Q9. Are you……? PLEASE TICK ONE BOX ONLY

Male	☐	Female	☐

Q10. Are you a ……? PLEASE TICK ONE BOX ONLY

Undergraduate Year 1 student	Undergraduate Year 2 student	Undergraduate Year 3 student	Undergraduate Year 4 student	Postgraduate Student
☐	☐	☐	☐	☐

Q11. What is your programme? PLEASE TICK ONE BOX ONLY

Biology	☐	Microbiology	☐	Biomedical science	☐
Ecotourism	☐	Animal biology	☐	Environmental biology	☐
Other (please specify)					

Q12. Finally, could you please enter your Edinburgh Napier matriculation/ ID number below?

Q13. We are planning to conduct two focus groups in the next couple of months about climate change and your thoughts on how you would like to learn about it. Please indicate below whether or not you would like to come along and we will contact you via email. The groups will take no more than an hour or so and beverages and snacks will be provided.

Yes, I would like to come along	☐	No, I am not interested	☐

Thank you very much for your help, it is much appreciated. Please remember that all the information you have given will be treated in the strictest confidence.
If you have any concerns please let us know or speak to the researcher.
If you would like to take part in a focus group about climate change in the near future please let the researcher know and she will take your details.
THANK YOU

Topic Guide – Climate Change – Stage One – Focus Group

Warm up and Classification

General introduction to group, outlining purpose

I am speaking to students at Edinburgh Napier who have been learning about climate change to find out what they think and feel about the subject and to explore what would be the best way to teach the subject

We have already done the first two parts of the project and this is the final part.

- Moderator to introduce themselves, saying what they do and a bit about their experience
- Please note that all the research is being done in accordance with the universities' ethics guidelines so what you say here is confidential
- Then to go round group – so each person gives their name, what they are studying and one interesting thing about them or what their hobby is or what they do in their spare time
- Please note that we will be recording the discussion
- Mention that we will be going straight through, refreshments are available, toilets are xxxx and where the fire door is in case the alarm goes off

General Discussion about climate change

- Give each a respondent a sheet paper and ask them to write down what their emotions and feelings are when the words "climate change" is mentioned or discussed
- Discuss all the emotions/ feelings with the group
- General views on climate change
- How well do you feel you understand the subject?
    - Too complicated

- Too much information
- Too many things to consider – politics/ science/ weather/ flooding/ mass migration etc
- Too many differing views on the subject
- Who do you listen to? Jeremy Clarkson/ or George Monbiot/ Al Gore

- How does it make you feel?
- If someone says 'climate change' to you what do you think of?
  - Ice caps melting/ rain/ hot weather/ cold weather/ species dying or moving/ people having to move etc
- Explore emotions surrounding it (use a flip chart/ paper) did it make you feel angry/ helpless/ motivated etc

General discussion teaching about climate change

- Did you study climate change before you attended university?
  - Where did you learn about it? School/ college/ etc
  - What did you learn?
  - How did you learn about it? Lectured to/ more involvement/ calculating carbon footprints/ planted trees etc
  - How effective was the teaching in terms of your attitude towards climate change – did it make you feel angry/ helpless/ motivated etc
  - What could have improved your learning process?
    - More interaction
    - Not learning about it
    - Not interested in parts of it e.g. politics is boring/ I don't understand the science
- How do you feel now that you have had more information about climate change?
  - Was interesting/ scary/ learnt a lot I didn't know/ cleared up a lot of the myths out there/
- What could have improved your learning process, if anything?
    - More interaction
    - Not learning about it

        - Not interested in parts of it e.g. politics is boring/ I don't understand the science
        - Nothing
- Do you now feel connected with the subject or is it still too big and scary to understand? Other reasons?
- Do you need to understand it or can you just say – 'the IPCC is right and we need to do something about it now!'
- What messages do you feel got through to you the best – what information had the most impact you?
- How would you like to be taught about climate change? Lectured to/ more interactive learning/ workshops/ planting trees/ others
- Should every undergraduate be taught about climate change?

Wind up

- One thing that politicians should do about climate change.
- One thing that you would like to do about climate change
- Any other comments/suggestions/recommendations

Thank and Close

Topic Guide – Climate Change – Stage Two Depth Interviews

Warm up and Classification

General introduction to group, outlining purpose

I am speaking to student at Edinburgh Napier who have been learning about climate change to find out what they think and feel about the subject and to explore what would be the best way to teach the subject –

We have already done the first three parts of the project and this is the final part.

- Moderator to introduce themselves, saying what they do and a bit about their experience
- Please note that all the research is being done in accordance with the universities' ethics guidelines so what you say here is confidential
- Please note that we will be recording the discussion

General Discussion about climate change – (section to be asked only if not interviewed before)

- Give each a respondent a sheet paper and ask them to write down what their emotions and feelings are when the words "climate change" is mentioned or discussed
- Discuss all the emotions/ feelings with the group
- General views on climate change
- How well do you feel you understand the subject?
    - Too complicated
    - Too much information
    - Too many things to consider – politics/ science/ weather/ flooding/ mass migration etc
    - Too many differing views on the subject

- Who do you listen to? Jeremy Clarkson/ or George Monbiot/ Al Gore
- How does it make you feel?
- If someone says 'climate change' to you what do you think of?
  - Ice caps melting/ rain/ hot weather/ cold weather/ species dying or moving/ people having to move etc
- Explore emotions surrounding it (use a flip chart/ paper) did it make you feel angry/ helpless/ motivated etc

General discussion teaching about climate change – (section to be asked only if not interviewed before)

- Did you study climate change before you attended university?
  - Where did you learn about it? School/ college/ etc
  - What did you learn?
  - How did you learn about it? Lectured to/ more involvement/ calculating carbon footprints/ planted trees etc
  - How effective was the teaching in terms of your attitude towards climate change – did it make you feel angry/ helpless/ motivated etc
  - What could have improved your learning process?
    - More interaction
    - Not learning about it
    - Not interested in parts of it e.g. politics is boring/ I don't understand the science
- How do you feel now that you have had more information about climate change?
  - Was interesting/ scary/ learnt a lot I didn't know/ cleared up a lot of the myths out there/
- What could have improved your learning process, if anything?
    - More interaction
    - Not learning about it
    - Not interested in parts of it e.g. politics is boring/ I don't understand the science
    - Nothing
- Do you now feel connected with the subject or is it still too big and scary to understand? Other reasons?

- Do you need to understand it or can you just say – 'the IPCC is right and we need to do something about it now!'
- What messages do you feel got through to you the best – what information had the most impact you?
- How would you like to be taught about climate change? Lectured to/ more interactive learning/ workshops/ planting trees/ others
- Should every undergraduate be taught about climate change?

Extra questions for those already interviewed

- How has your views/ actions with regard to climate change changed since we last spoke?
- Do you feel that you have learnt a lot in the last year?
- Thinking back to your Climate Change lectures were your fellow students thinking the same? Do you know how they felt? Did you discuss this at the time? Or since?
- Do you still feel that small steps are good when changing people's actions/ thoughts
- Discuss resilience, emotional strength etc – do you need to be a strong person to handle climate change?
- Are there people who cannot handle climate change and who not have strength/ resilience?
- Is it possible that there is a generation of bubble-wrapped children/ young adults who are unable to cope with it
- Undergraduates – should they be told?
- Should children be told about climate change? Should they be told at the end of this world as we know it is going to happen?
- How do you teach risk and uncertainty? What are the problems with this?
- Threshold concepts and troublesome knowledge – is this what students need to be overcoming and crossing?
- Any other comments/suggestions/recommendations

Thank and Close

Appendix 2

Residual Plots for postemo-preemo

Regression Analysis 1: postknow-preknow versus postemo-preemo

The regression equation is

postknow-preknow = 1.46 + 0.255 postemo-preemo

Predictor	Coef	SE Coef	T	P
Constant	1.4608	0.3938	3.71	0.000
postemo-preemo	0.2555	0.1210	2.11	0.038

S = 3.03977 R-Sq = 6.2% R-Sq(adj) = 4.8%

Analysis of Variance

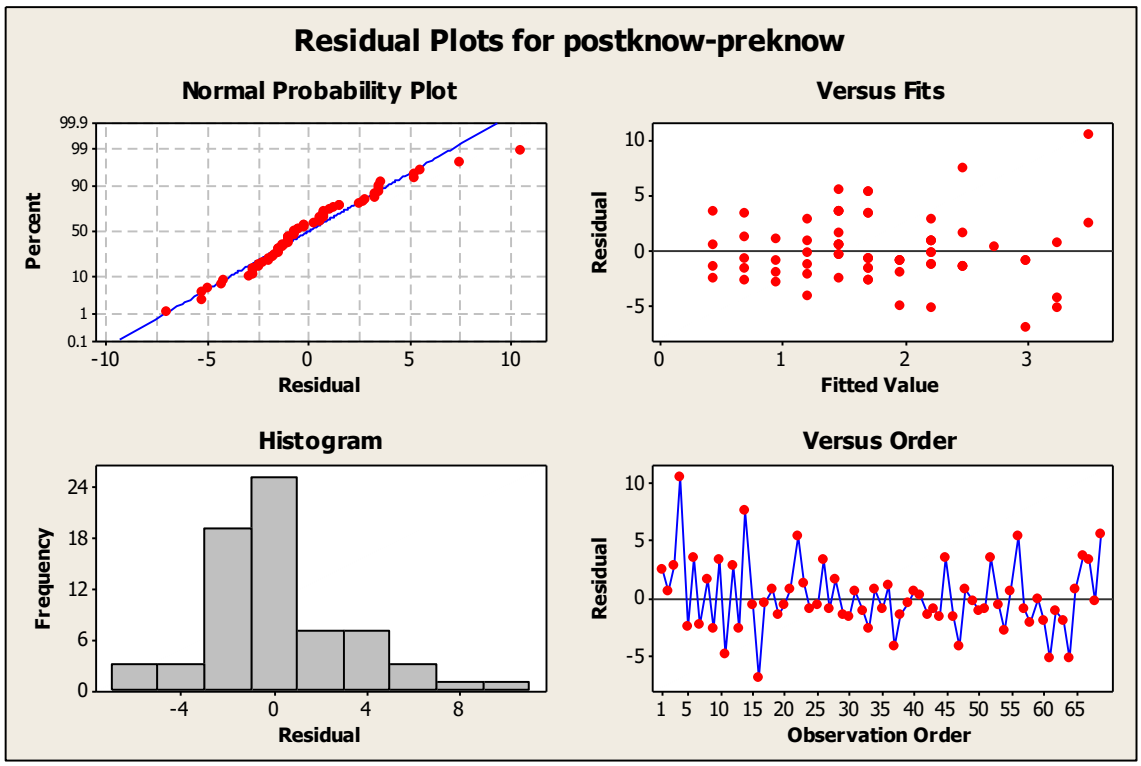
Source	DF	SS	MS	F	P
Regression	1	41.195	41.195	4.46	0.038
Residual Error	67	619.095	9.240		
Total	68	660.290			

Unusual Observations

Obs	postemo-preemo	postknow-preknow	Fit	SE Fit	Residual	St Resid
1	8.00	6.000	3.505	0.900	2.495	0.86 X
4	8.00	14.000	3.505	0.900	10.495	3.61RX
14	4.00	10.000	2.483	0.498	7.517	2.51R
16	6.00	-4.000	2.994	0.686	-6.994	-2.36R

R denotes an observation with a large standardized residual.

X denotes an observation whose X value gives it large leverage.


Residual Plots for postknow-preknow
Normal Probability Plot
Percent
99.9
99
90
50
10
1
0.1
-10
-5
0
5
10
Residual
Versus Fits
Residual
10
5
0
-5
0
1
2
3
Fitted Value
Histogram
Frequency
24
18
12
6
0
-4
0
4
8
Residual
Versus Order
Residual
10
5
0
-5
1 5 10 15 20 25 30 35 40 45 50 55 60 65
Observation Order

Appendix 3 – Segmentation Analysis

knowledge and emotional type	Total emotional response	Q4. importance of climate change	Q5. knowledge - overall score	Q6. Overall awareness of greenhouse gases	Q7. overall awareness of increasing temperature score	Q9 current change	Q10. Activities future change	Total people
know less+less worried	negative	dec importance	same/ better	Same/ better	same/ better	None to little change	None to little change	5
know less+more worried	positive	inc importance	same/ better	Same/ better	same/ better	None to little change	Some to lots of change	3
know less+same	negative	inc importance	same/ better	Same/ better	less	None to little change	No to some change	3
know more+less worried	positive	dec importance	same/ better	Less	same/ better	Some to lot of change	Some to lots of change	3
know more+more worried	positive	inc importance	same/ better	Same/ better	same/ better	Some to lot of change	Some to lots of change	22
know more+same	positive	inc importance	same/ better	Variable knowledge	same/ better	variable current change	Some to lots of change	9
same+less worried	positive	variable importance	same/ better	Same/ better	same/ better	None to little change	Some to lots of change	6
same+more worried	positive	inc importance	same/ better	Variable knowledge	Variable knowledge	Some to lot of change	Some to lots of change	8
same+same	positive	inc importance	same/ better	Variable knowledge	same/ better	None to little change	Some to lots of change	10
								69