Low factual understanding and high anxiety about climate warming impedes university students to become sustainability stewards

An Australian case study

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Abstract

Purpose – This study, from Western Sydney University, aims to assess the disposition of students towards climate warming (CW) – a key component of sustainability. CW is a global reality. Any human born after February 1985 has never lived in a world that was not constantly warming, yet little is known about how higher education students perceive their future in a warming world.

Design/methodology/approach – An online survey, split into three parts, was used to deliver benchmark data on (I) personal information, (II) factual knowledge and (III) sentiments related to CW.

Findings – Gender and age of students significantly influenced their perception of CW. While self-rated understanding of CW was generally high, factual knowledge about CW was low. Few students recognized that CW was already under way, and that it was mainly caused by human activity. The most prominent emotions were fear, sadness and anger, foretelling widespread disempowerment and fear for the future.

Research limitations/implications – The study was based on a single dataset and survey response was relatively low. However, respondents mirrored the composition of the student community very well.

Originality/value – This is the first study revealing large psychological distance to the effects of CW in university students from Australia. Combined with the impression of despondence, the present study suggests that higher education in Australia, and possibly elsewhere, is not providing the prerequisite tools tomorrow's leaders require for meeting societal, environmental and economic challenges caused by CW. Practical ways to erase these blind spots in sustainability literacy are provided, drawing upon established and novel concepts in higher education.

Keywords Higher education, Gender, Climate change, Age, Psychological distance, Sustainability education

Paper type Research paper

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1. Introduction

Scientific consensus that climate change is affecting the Earth system in multiple ways has long been reached (Cook *et al.*, 2015; Frank *et al.*, 2015; Walther *et al.*, 2005). The resultant climate warming[1] (from hereon abbreviated "CW") is irreversible and mostly a result of human activity (IPCC, 2014; Solomon *et al.*, 2009). Global average surface temperatures in 2016 were the highest, and the five-year interval 2011-2015 was the warmest since recording of temperature data started 160 years ago (WMO, 2015). Based on global, long-term temperature observations (NOAA, 2014), any human born after February 1985 has never experienced a cooler-than-average month in their entire life. This means that in 2015, more than 3 billion people (CIA, 2013) have never lived in a world that is not continuously warming. In Australia, this equates to 41 per cent of the population, or 9,730,000 individuals that are aged 30 years or younger (Australian Bureau of Statistics, 2015). It remains elusive, how growing up with increasing scientific certainty that planet earth is warming, affects the worldview of young people.

Effects of CW are highly complex, diverse and impact all humans, regardless of age. Effects can be direct, such as rising sea level and associated loss of habitat (Alongi, 2015; Lovelock *et al.*, 2015), have a negative economic impact by means of losses in agricultural production (Kurukulasuriya and Rosenthal, 2003) or promote arrival of animals and plants that were formerly uncharted in a particular climate zone (Root *et al.*, 2003); not to mention the risk of species extinction (Urban, 2015). Many other psychological, socio-cultural, economic, geopolitical and biological effects are described in the vast literature available about the topic (e.g. Pfautsch *et al.*, 2010a, 2010b; Pfautsch and Adams, 2013; Drake *et al.*, 2015).

To initiate a sustainable and enduring response to these and other effects of CW, the prerequisite for personal and immediate experience is needed (Akerlof *et al.*, 2013) to minimize "psychological distance" (*sensu* McDonald *et al.*, 2015). The lack of a perceived direct threat was suggested to result in a reduced aptitude for taking action and/or adapting to effects of CW (Lorenzoni *et al.*, 2006; Newell *et al.*, 2014; Weber, 2006, 2010). However, for the vast majority of individuals of any age group, it is almost impossible to immediately and directly experience CW because of the slow increase and natural variability of global surface temperatures (Hulme, 2009). Knowledge about principles of sustainability and also CW is primarily gained from experts, not by personal experience (Cortese, 2003; Sundblad *et al.*, 2009). Additional factors such as, but not limited to, individual psychological wellbeing, socio-cultural conditions and economic prospect (see Clayton *et al.*, 2015) may also influence how threats and opportunities related to CW are perceived. Political partisanship (Nisbet *et al.*, 2015), even gender (Bliuc *et al.*, 2015), emotional affiliation (Gray and Birrell, 2015; Gray and Thomson, 2016) and religious believes (Murphy *et al.*, 2016) can further influence behavioral change to combat CW and adopt environmental stewardship.

A core argument to foster behavioral change that assists in slowing CW is the moral obligation to preserve living conditions and natural resources for future generations. This argument overlooks that CW is taking place today. Cortese (2003) argues that actions of past graduates from the best colleges and universities around the world have led to the present situation. Although Cortese's argument leaves out other attributing factors, it puts higher education into the spotlight of the discussion. Given that most of today's university students grew up in a constantly warming world, it also raises the question of how higher education contributes to increase the chance that graduates feel empowered to implement wider behavioral changes that are required to limit CW. Here,

effective education on principles of sustainability plays a key role (Dmochowski *et al.*, 2016).

It can be assumed that there is a high likelihood for today's university students to become leaders of tomorrow in our societies (politically, economically, etc.). In these prospective roles, they can become guardians of sustainability if relevant knowledge is provided and student's capacity for critical analysis, particularly systems thinking (Wiek *et al.*, 2011) is stimulated. The importance of knowledge and education in taking action against CW has been documented (Lazo *et al.*, 2000; O'Connor *et al.*, 1999, 2002). Yet, to effectively engage students in curricular activities that foster their sustainability literacy, it is important to first understand their current sentiment and knowledge of CW. Armed with this information, the higher education industry can develop tools (e.g. cross-disciplinary lectures, degrees, summer schools and research emphasis) that enable students to meet challenges in their forthcoming leadership roles. As the number of students enrolling in higher education institutions is increasing worldwide, the urge for providing future-proof education is rising.

This is particularly important for Australia, the driest permanently populated continent. Besides shared global effects of CW, Australia experiences climate extremes such as droughts, floods, hailstorms and heat waves on an annual basis. These events are forecasted to further increase in their frequency (Hennessy, 2011; IPCC, 2014). Recent surveys documented that more than half of Australian participants regarded CW as a "serious and pressing problem" (Oliver, 2015, p. 3) and have personally experienced negative effects of climate extremes (Leviston *et al.*, 2015). Effects of the predicted increase in climate-driven calamities in Australia – and possibly elsewhere – include reduced availability of potable water, negative effects on biodiversity, ecosystem resilience and tourism, increased frequency of severe bush fires and loss of agricultural productivity, to name a few (Garnaut, 2008; Hennessey, 2011). These effects are likely to cause complex, yet unpredictable societal impacts. Young Australian adults must be provided with future-proof education that delivers the tools necessary to identify and manage these impacts.

A number of studies have evaluated how young American adults that grow up in a warming world perceive their future (Cordero *et al.*, 2008; Feldmann *et al.*, 2010; Wachholz *et al.*, 2014; Wilson and Henson, 1993). These surveys revealed unanimously that young Americans were surprisingly disengaged and disconnected with the topic. Even after participation in science courses that dealt with concepts and consequences of CW, misconceptions remained and personal engagement remained low (Cordero *et al.*, 2008). These observations from the USA could be interpreted as testament for an alarming shortcoming in higher education, in particular for provision of effective sustainability literacy. It is currently unknown if a similar situation exists in Australia and engagement and competency of university students in topics related to CW remains underdeveloped. This fact provided the impetus for the present study.

Centered around CW, the aim of the present study was as follows:

- to identify current attitudes among metropolitan university students; and
- to assess how gender and age influence their views.

Very little is known about how gender and age of young adults impact cognition of CW (Arona-Jonsson, 2011; Bliuc *et al.*, 2015; Feldmann *et al.*, 2010; Wachholz *et al.*, 2014), yet such information can be used to increase the effectiveness of university education. Based on widespread personal experiences and concerns related to CW in the Australian society (Leviston *et al.*, 2015; Reser *et al.*, 2012), it was hypothesized that:

- Factual knowledge of university students about CW is proficient and does not differ among gender or age group.
- If students think their life would be affected by CW, then their motivation to take action against increasing CW is high.

2. Material and methods

This study encompassed an online survey to gain insights about the cognition on CW of university students. The survey was rolled out electronically across the Western Sydney University (WSU), one of five universities in the Greater Sydney Region. WSU was founded in 1989 and sources the majority of its students from a region to the South-West, West and North-West of metropolitan Sydney, Australia. In 2014, this region had a population of 2.12 million, and added social, economic and cultural significance to the state of New South Wales due to its rapid development (Montoya, 2012). The population of this region is known to be cosmopolitan and multicultural. In 2014, 32,941 full-time equivalent students were enrolled, and 9,029 completed their studies on eight different campuses. About one-eighth were international students, the vast majority was under 25 years of age and 60 per cent of the students were the first in their family to attend university. WSU belonged to the top 2 per cent of universities worldwide (2014 Times Raking). According to the Excellence of Research Assessment 2015, 80 per cent of research at WSU was ranked "world standard" or above, signifying the competitive study environment at WSU.

2.1 Survey structure and content

Following approval (Project Approval Number *H11133*) by the Human Research Ethics Committee of WSU (EC00314), an invitation to participate in an online survey was sent electronically to the students in June 2015 through the Academic Registrars Office. The survey was accessible through computers, tablets and mobile phones for four weeks. It was anonymous and originally consisted of 19 questions that related to CW. Here we excluded one question (*What degree are you enrolled in?*), as no trends were found in this specific data set. The remaining list of 18 questions and possible answers are provided in Figure 1. We used the works of Leviston *et al.* (2015) and Feldmann *et al.* (2010) as a guideline for formulation of questions, allowing cross-comparisons of focus groups. The structure of the survey was divided into three sections. The first section consisted of three questions about the student's age, gender and migration background. The next nine questions established the standard of knowledge; the final six questions assessed perceptions about CW. A range of inquiry techniques was used, including rankings, multiple choice and free text. The survey was constructed using a free online platform (www.qualtrics.com).

2.2 Demographic background of participants

A total of 143 students participated in and 123 completed the survey (response rate of 0.005 per cent). The average age, gender mix and migration background of participants was composed of a representative cross-section of the student body at WSU. In 2014, 67 per cent of WSU students were younger than 25 years of age, of which 55 per cent were female and 45 per cent male. Age of survey participants was capped at 50 years and average age of participants was 25.2 years, with 17 and 49 years being absolute minimum and maximum age, respectively; 51 per cent were 22 years of age or less. Participants of this group were

Question 1: What is your age?

_____ Use lever to select your age (limited to 15-50 years of age)

Question 2: What is your gender?

❍ Male
❍ Female
❍ Leave blank

Question 3: What is your cultural background? (Select one or more)

❑ Parents born in Australia
❑ Parents not born in Australia
❑ Permanent resident
❑ Recent migrant
❑ Other
❑ Leave blank

Question 4: When did you first hear about climate warming?

❍ Never
❍ Primary School
❍ High School
❍ University
❍ Other

If *Other* is selected, than

Question 4.1: Please specify where you first hared about climate warming. (Free text)

Question 5: Please use slider to indicate how credible you think information about climate warming is from the following sources. Think of these sources 'in general' and not of specific individuals that may be part of a source. (1 = not credible, 10 = highly credible)

_____ Politicians
_____ Climate Scientists
_____ Classic Print Media (like SMH, NY Times)
_____ Social Media (like Facebook, Twitter)
_____ Science Journals (like National Geographic, Science Today)

Question 6: When do you expect climate warming to take place? (Select one or more)

❑ Now*
❑ 2030*
❑ 2050*
❑ 2100*
❑ Not sure

If *Not sure* is selected, than

Question 6.1: Would you be able to specify why you are not sure about when you expect climate warming to take place? (Free text)

Question 7: How would you rate your understanding of the underlying mechanisms that seem to lead to climate warming? (1 = no understanding, 10 = highly detailed understanding)

_____ Level of understanding

Question 8: What statement do you think is most accurate?

❍ Climate warming is entirely caused by natural processes
❍ Climate warming is mainly caused by natural processes
❍ Climate warming is partly caused by natural processes and partly caused by human activity
❍ Climate warming is mainly caused by human activity*
❍ Climate warming is entirely caused by human activity
❍ There is no such thing as climate warming

Question 9: Are you aware of any key climate warming related events that took place in the previous year?

❍ Yes
❍ No

If *Yes* is selected, than

Question 9.1: What event(s) do you refer to? (Free text)

Question 10: Who is the world authority on climate warming effects?

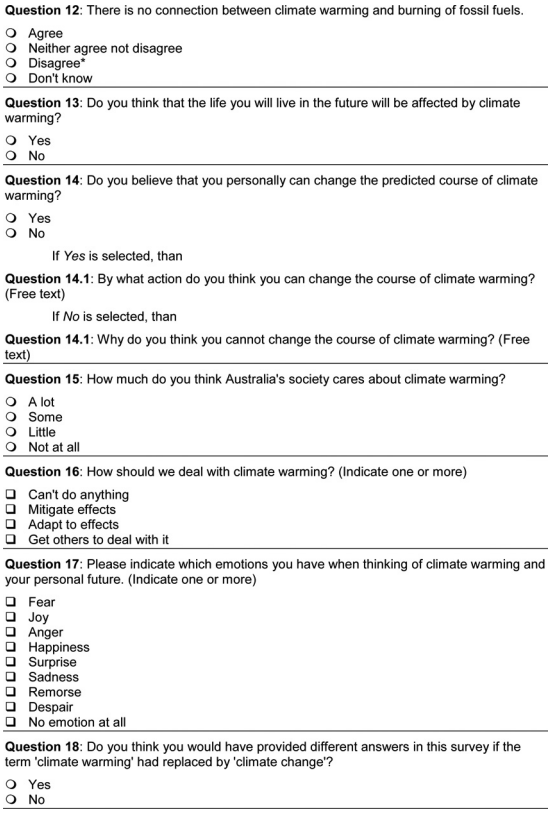
❍ UN
❍ IMF
❍ IPCC*
❍ UNHCR
❍ Don't know

Question 11: On average, how much warmer do you think Sydney will be in 50 years?

❍ Same as today
❍ +1 °C
❍ +2.5 °C*
❍ +5 °C
❍ More than+5°C
❍ Not sure

(*continued*)

Figure 1.
Complete online survey. Asterisks indicate correct factual answers



Question 12: There is no connection between climate warming and burning of fossil fuels.

- ❍ Agree
- ❍ Neither agree not disagree
- ❍ Disagree*
- ❍ Don't know

Question 13: Do you think that the life you will live in the future will be affected by climate warming?

- ❍ Yes
- ❍ No

Question 14: Do you believe that you personally can change the predicted course of climate warming?

- ❍ Yes
- ❍ No

If *Yes* is selected, than

Question 14.1: By what action do you think you can change the course of climate warming? (Free text)

If *No* is selected, than

Question 14.1: Why do you think you cannot change the course of climate warming? (Free text)

Question 15: How much do you think Australia's society cares about climate warming?

- ❍ A lot
- ❍ Some
- ❍ Little
- ❍ Not at all

Question 16: How should we deal with climate warming? (Indicate one or more)

- ❑ Can't do anything
- ❑ Mitigate effects
- ❑ Adapt to effects
- ❑ Get others to deal with it

Question 17: Please indicate which emotions you have when thinking of climate warming and your personal future. (Indicate one or more)

- ❑ Fear
- ❑ Joy
- ❑ Anger
- ❑ Happiness
- ❑ Surprise
- ❑ Sadness
- ❑ Remorse
- ❑ Despair
- ❑ No emotion at all

Question 18: Do you think you would have provided different answers in this survey if the term 'climate warming' had replaced by 'climate change'?

- ❍ Yes
- ❍ No

Figure 1.

termed "younger students", while those 23 years of age and older were termed "older students".

More female (n = 76 [62 per cent]) compared to male students (n = 47 [38 per cent]) participated. Young female students represented the largest cohort (37 per cent), followed by older female students (25 per cent), older male students (24 per cent) and younger male students (14 per cent). Reflecting the multicultural nature of the WSU student cohort, 52 per cent of the participants indicated that their parents were born in Australia, 41 per cent had parents born outside of Australia and one student was a recent migrant. Students whose parents were not born in Australia were slightly younger (24.4 years) compared to students whose parents were born in Australia (25.7 years). The male/female ratio in both student groups was about 1:2; the proportion of slightly younger compared to older students was similar in the two groups.

2.3 Data analyses

Pearson's product moment correlation matrices were used to identify significant effects and their direction on selected variables. Differences between male and female as well as younger and older students in their confidence of understanding the underlying mechanisms that lead to CW were assessed using parametric and non-parametric (Kruskal–Wallis ANOVA) tests. One-way ANOVA was used to evaluate students confidence in the

sources of information (politicians, climate scientists, etc.) and their self-rated understanding of the mechanisms underlying CW and other variables. A post-hoc test (Levene's test for equality of variances) was used to cross-check significant affects. When assessing nested effects of variables (e.g. effect of gender on perception that CW effects personal life), Chi-square (χ^2) tests were used. For statistical analyses, JMP® (V11, SAS Institute Inc., USA) and SPSS® (V21.0, IBM Corp., USA) software packages were used. Figures were produced using Aabel™ (V2.0, Gigawiz Ltd Co., USA).

3. Results

3.1 Self-rated understanding

The self-assessed confidence in understanding the underlying mechanisms of CW was significantly greater ($t(119) = 2.08$, $p < 0.05$) in male ($M = 6.56$, SD 2.20) compared to female ($M = 5.74$, SD 2.02) students (Table I). No such difference existed between younger and older students ($t(119) = 0.38$, $p > 0.05$) or those with and without a more recent migration background ($t(118) = -1.05$, $p > 0.05$). Within the group of male students, those ≤ 22 years of age were most confident ($M = 6.71$, SD 2.52), and close to one-third of participants in that group rated their understanding with the highest possible score of 10. Older male students as well as all female students were more moderate in their self-rating (score of 10: 7 per cent older male, 2 per cent younger female and 0 per cent older female students).

3.2 Factual knowledge

The vast majority of students (89 per cent) had first heard about CW prior to enrolling in university, either in primary or high school. The remaining students, all 30+ years of age, had learned of CW through media or university. About half of the students (53 per cent male and 46 per cent female) were not able to name a key event in the previous year that was related to CW. Events that were listed by students fell into four common themes, listed by prevalence: I. Increasing rates of polar ice melt and subsequent rise in sea level, II. Local and global events related to extreme weather or natural disasters (e.g. Amazonian drought, increased risk of bushfires, Super-typhoon Haiyan), III. General warming of earth's climate, IV. Policy changes or political events (e.g. governmental statements to reduce dependency on coal, G7 summit, EarthHour). The direct relatedness to CW of numerous answers falling under Categories II and IV was fuzzy.

All students, except two males, acknowledged the existence of CW. A large proportion of both male and female students correctly believed that CW was *mainly* caused by human activity (Figure 2). However, a significantly larger group of female students compared to male students (both age cohorts) thought that a mix of human activities and natural processes caused CW. While no participant thought that CW was the exclusive result of natural processes, only 13 per cent male and 12 per cent female students saw CW entirely as a consequence of human activity (Figure 2).

Table I. Gender and age-cohort differences in response to Question 7 of the survey (see Figure 1)

Q7: How would you rate your understanding of the underlying mechanisms that seem to lead to CW (1 = no understanding; 10 = highly detailed understanding)?	Whole sample ($n = 123$)	Male ($n = 47$)	Female ($n = 76$)	Younger ($n = 63$)	Older ($n = 60$)
Understanding	6.04 (2.12)	6.56 (2.20)	5.74 (2.02)	6.11 (2.17)	5.97 (2.08)

Given that the majority of students identified human activity as foremost cause for CW, it was surprising that nearly none of them agreed that there was a connection between CW and burning of fossil fuels. Only three female students agreed on this causal nexus. Equal proportions (35 per cent) of younger and older male students stated that CW was not happening today and projected its occurrence into the near future (2030-2050). Compared to male students, significantly less female students did not think CW was happening today (22 per cent younger, 16 per cent of older students; $p < 0.001$). Only five students indicated that CW was happening now and in the future by selecting multiple answers, including "now".

The response when asked how warm the Sydney region will be in 50 years differed significantly between genders ($\chi^2(5) = 19.90$, $p < 0.05$, see Table II) and age groups (young males vs young females = $p < 0.002$; older males vs older females = $p < 0.005$). Female students, independent of age, thought that average temperatures would be +5°C or more compared to today (Table II), whereas most male students thought that temperatures would increase by +2.5°C. Only one female and two male students thought there would be no change in temperatures.

One quarter of students identified the International Panel of Climate Change (IPCC) correctly as world authority on CW effects. Other options to choose from where the UN (17 per cent), IMF (0 per cent), UNHCR (6 per cent) or *don't know* (46 per cent). When split by gender, only one-third of the male students (7 per cent younger, 24 per cent older students), and one-fifth of the female students (10 per cent younger, 11 per cent older students) correctly identified the IPCC. The overall likelihood to correctly identify the IPCC was positively and significantly related to the participant's self-rated understanding of CW mechanisms ($p < 0.05$, Table III).

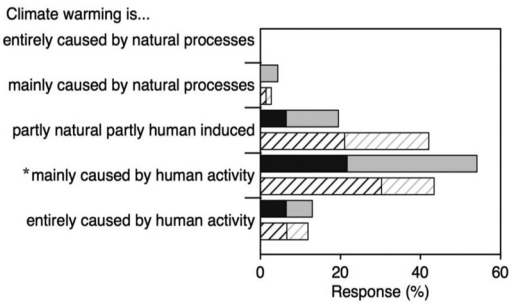


Figure 2.
Response ratio of male (solid; $n = 47$) and female (hatched; $n = 76$) students when asked to indicate which of the statements about the cause of CW is most correct (Question 8, see Figure 1). The correct answer is marked with an asterisk. Data were separated by age (black = students ≤22 years of age, grey = students ≥23 years of age)

Table II.
Gender differences in responses for Question 11 of the survey (see Figure 1). The correct answer is marked with an asterisk

Q11: On average, how much warmer do you think Sydney will be in 50 years?							
	Same as today	+1°C	+2.5°C*	+5°C	> +5°C	Not sure	Total
Male	4.70 (2)	23.30 (10)	32.60 (14)	7.00 (3)	4.70 (2)	27.90 (12)	100.00
Female	1.30 (1)	13.30 (10)	26.70 (20)	26.70 (20)	22.70 (17)	9.30 (7)	100.00
Total	2.50 (3)	16.90 (20)	28.80 (34)	19.50 (23)	16.10 (19)	16.10 (19)	(118)
Chi-square	19.90	$p < 0.05$					

When asked about the credibility of information on CW, the majority of both male and female students – regardless of age – ranked climate scientists and popular science journals (e.g. National Geographic and Science Today) as most credible sources (Table IV). Other sources, such as print media (e.g. Sydney Morning Herald and New York Times) or social media (e.g. Facebook and Twitter) were identified as much less credible sources. Politicians were the least credible source of information on CW. Even though the latter three sources were associated with the lowest credibility, all three were significantly and positively correlated with self-rated understanding of participants (Table III), indicating that participants with a higher self-rated understanding were more likely to also score credibility of print and social media and politicians higher. No such trend was found for credibility of climate scientists or popular science journals.

3.3 Perceptions

Students regarded that Australians cared *little* or *some* about CW, only 3 per cent thought that Australians cared *a lot*. At the more personal level, 85 per cent of students indicated that their life would be affected by CW in the future. This expectation differed significantly between genders ($\chi^2(1) = 8.95$, $p < 0.05$, Table V), with female students rating odds that their lives will be affected by CW 8.34-times higher compared to their male counterparts. Surprisingly, students that thought their lives would not be affected thought their understanding of underlying mechanisms of CW was relatively high (mean score: 7/10).

The widely shared anguish is further reflected in *fear* being the most common emotion (n = 58/123) of participants when thinking how CW will impact their future, followed by *sadness* (n = 50/123), *anger* (n = 40/123), *despair* (n = 32/123) and *remorse* (n = 26/123)

	1.	2.	3	4.	5.	6.	7.	8.
1. Understanding (Q7)	1							
2. Politicians (Q5)	0.35**	1						
3. Scientists (Q5)	−0.08	−0.08	1					
4. Print Media (Q5)	0.26**	0.40**	0.16	1				
5. Social Media (Q5)	0.27**	0.40**	0.08	0.68**	1			
6. Journals (Q5)	−0.06	0.11	0.68**	0.23**	0.15	1		
7. Authority[a] (Q10)	0.21*	0.01	0.07	0.06	0.02	0.04	1	
8. Affect (Q13)	0.15	−0.05	−0.47**	−0.13	−0.06	−0.35**	0.10	1

Notes: n = 123; *$p < 0.05$, **$p < 0.01$; [a]This item has been recoded as a dichotomous item representing the possibility of correctly (1) identifying IPCC as the world authority or not (0)

Table III. Correlation matrix related to Questions 5, 7, 10 and 13 of the survey (see Figure 1)

Q5: Indicate how credible you think information about CW is from the following sources (1 = not credible; 10 = highly credible).

	Whole sample (n = 123)	Male (n = 47)	Female (n = 76)	Younger (n = 63)	Older (n = 60)
Politicians	2.69 (1.92)	2.74 (1.76)	2.66 (2.02)	2.73 (2.13)	2.65 (1.69)
Climate scientists	8.34 (2.32)	8.06 (2.74)	8.52 (2.02)	8.55 (2.19)	8.13 (2.46)
Print media	3.83 (2.25)	3.72 (2.40)	3.89 (2.17)	4.19 (2.23)	3.45 (2.23)
Social media	3.41 (2.44)	3.34 (2.65)	3.45 (2.31)	3.71 (2.62)	3.10 (2.21)
Science journals	7.94 (1.99)	7.64 (2.34)	8.13 (1.73)	8.24 (1.79)	7.63 (2.15)

Table IV. Gender and age-cohort differences in response to Question 5 of the survey (see Figure 1)

(multiple selections were possible; Figure 3). While only three participants selected *surprised*, 21 opted to have *no emotion* when thinking about CW. Response ratios for *fear*, *sadness*, *anger*, *despair* and *remorse* were generally higher for young female compared to young male students (Figure 3). However, younger female and older male students generally scored higher response scores than young male and older female students. A clear gender difference was only prevalent for the choice *no emotion*, being selected by nearly twice as many male than female students (Figure 3).

The question if participants personally think they can change the course of CW was answered by 51 per cent of all participants with "no". This group consisted equal proportions of younger and older males (61 per cent each) and older females (64 per cent). When asked for a reason, the majority stated that their individual contribution toward change would have no effect. However, when provided four choices how to deal with CW (1. Can't do anything, 2. Mitigate effects, 3. Adapt to effects, 4. Get others to deal with it; see Q16 in Figure 1), only 5/123 remained convinced that nothing could be done. Younger female students appeared more positive toward their own contribution, and 47 per cent of that group thought their personal actions can change the predicted course of CW. A smaller proportion of the participants belonging to each of the remaining three other groups (older female: 36 per cent, younger and older males: each 39 per cent) were of the same opinion.

Table V.
Gender differences in responses for Question 13 of the survey (see Figure 1)

Q13: Do you think that the life you will live in the future will be affected by CW?	Yes	No	Total
Male	81.40 (35)	18.60 (8)	100.00
Female	97.30 (73)	2.70 (2)	100.00
Total	91.50 (108)	8.50 (10)	(118)
Chi-square	8.95*		

Note: * $p < 0.05$

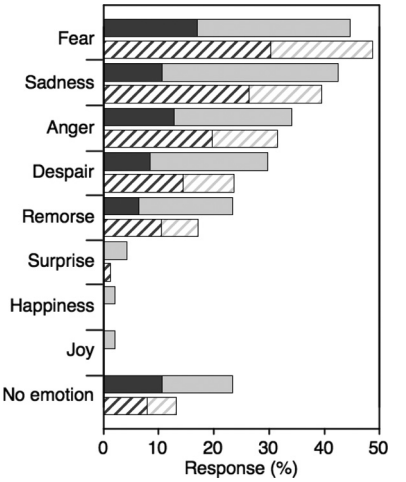


Figure 3.
Response ratio for male (solid; $n = 47$) and female (hatched; $n = 76$) students when asked to select emotions that capture their state of mind about CW and their own future (Question 17, see Figure 1). Data were separated by age (black = students ≤22 years of age, grey = students ≥23 years of age)

Regardless of gender and age, students thought that mitigation of CW is more important compared to adaptation or waiting for others to take action.

Suggestions for personal actions that help limit CW were (in order of frequency):

- Increase power generation from renewable sources (particularly solar);
- Increase waste recycling;
- Increase education of the public on sustainable living;
- Increase use of public transport;
- Reduce use of fossil fuels (particularly coal); and
- Elect more politicians that actively endorse actions that aim to limit CW.

Somewhat surprisingly, no student suggested that provision of knowledge on impacts and mitigation of effects of CW in their university curriculum could be improved.

4. Discussion

Results presented here unveil for the first time that factual knowledge and emotional perception of Australian university students on CW is significantly influenced by gender and age. This stands in contrast to a wider cross-section of the Australian population (Leviston *et al.*, 2015) and refutes the first hypothesis. Among students of a metropolitan Australian university, the present study detected significant differences in self-rated understanding and factual knowledge of CW between age and gender groups. Irrespective of any grouping, most students share the understanding that CW is mainly a result of human activity, and to a lesser part that of natural processes. This is in agreement with other studies from Australia (Reser *et al.*, 2012; Leviston *et al.*, 2015). In addition, both the present study and that of Leviston and colleagues (2015) found similar rankings in credibility of information provided by a range of sources. Climate scientists were always the most, politicians and social media the least credible source. The low credibility score for social media was surprising, given that participation of scientists in blogs and other digital platforms has increased (Pearce *et al.*, 2015).

The understanding of CW by laypersons across the world has been described to be vague and with a high level of confused facts (Böhm and Pfister, 2001). Risks associated with false confidence in personal knowledge about CW have been identified (Sundblad *et al.*, 2009). These studies provided evidence that high confidence, paired with low factual knowledge, bared an increased risk to deny learning of new knowledge. In this light, the level of inconsistency between self-rated understanding (high) and factual knowledge (low) of Australian university students on CW was surprising. A striking example for divergence of thinking to know and actually knowing is the unawareness of nearly all students that burning of fossil fuels is largely contributing to CW.

While the present study found an imbalance between assumed and actual knowledge, other studies found a divergence between intention and action related to combat effects of CW (Whitmarsh, 2009b). We argue that both types of disagreements are intertwined as both limit the capacity to initiate change. Such change requires making decisions, and specific knowledge is necessary to inform these decisions. Lazo *et al.* (2000) have provided evidence that increased knowledge about CW leads to greater public support of CW-related policy changes. These observations underpin the importance of knowledge transfer by experts but

also highlight that the issue of assumed and factual knowledge must be broached before new information can be learned.

The expectation of students to live in a warmer world reflects a broader understanding of the Australian public (Leviston *et al.*, 2015). The present study provides an interesting nuance of that expectation by revealing that a large proportion of male and female students are expecting higher temperatures by 2050 (+5°C or more than currently predicted). Depending on underlying emission scenarios, available climate projections by CSIRO indicate that in 2090 (40 years later!), temperatures in the Sydney region could increase between 1.3°C and 2.5°C (intermediate emission scenario) and 2.9°C and 4.6°C (high emission scenario). Hence, students expect to live in an even more hostile environment than currently predicted. This expectation fits well with widely shared negative emotions of fear and sadness and the overestimated level of factual knowledge. Moreover, it promotes the type of inaction that seems widespread about the participants of the current study: the majority opted for mitigation as most auspicious strategy to combat CW, but more than 50 per cent of participants did not think they can personally contribute to the process. Based on this result, the second hypothesis must be rejected, leading to the conclusion that many students have not yet noticed how their personal lifestyles actively contribute to CW.

In this context, it is important to realize that current knowledge on pro-environmental attitudes and behavior of individuals contains only scant ideas of why individuals take actions that assist in mitigating CW (Semenza *et al.*, 2008; Bernie, 2014). The few studies available on this issue have identified reduced self-awareness as principal constraint to defining and implementing effective strategies to mitigate CW (Whitmarsh, 2009b). Here higher education should play a more prominent role. Interdisciplinary lectures (Davison *et al.*, 2014; Mobley *et al.*, 2014; Rogers *et al.*, 2015) and practical exercises (Savageau, 2013; Wiek *et al.*, 2014) in science, technology, engineering and mathematics (STEM) teaching have been identified as tools that can help reduce this constraint by raising awareness of personal actions that impact CW.

Emphasis is put on STEM students, as their potential impact on society through technological innovation is most apparent. However, STEM students often lack exposure to humanities and social sciences where important principles of sustainability, including moral and ethical dimensions, are taught (Biedenweg *et al.*, 2013). Hence, increasing sustainability competency, initiating personal action and reducing CW-related despondence of university students should be encouraged through teaching technical as well as ethical aspects of sustainability. Ideally, development of such novel coursework involves substantial participation of students through steering committees and discussion groups. Intense consultation with students was shown to increase effectiveness and uptake of the novel lessons (Wachholz *et al.*, 2014).

For example, calculating personalized carbon emission budgets and or ecological footprint (Cordero *et al.*, 2008) of students can be used to promote self-awareness. Other practical classroom examples that address relevant issues can be found in the literature (Bell *et al.*, 2012; Jacobsen *et al.*, 2012). Developing solutions for real-world scenarios, as well as using existing case studies have also been proven useful to raise self-awareness and improve sustainability literacy (Remington-Doucette and Musgrove, 2015). More palpable are courses on aspects of sustainability in engineering (i.e. industrial ecology), offered at under- and postgraduate levels at selected Australian universities (Biswas, 2011). Equally encouraging are developments for interdisciplinary teaching on topics related to climate change (Mobley *et al.*, 2014; Rogers *et al.*, 2015).

According to psychological research, risk is often assessed in emotional, rather than analytical context (e.g. Slovic and Peters, 2006; Finucane, 2008). This contention also applies

to possible risks associated with CW (Leiserowitz, 2006; Smith and Leiserowitz, 2014). While negative emotions of students about their future entice to lethargy, they may serve as prerequisite for a more vigilant and thoughtful processing of available information (Finucane, 2008; Schwarz *et al.*, 1991). Harnessing the dominance of negative emotions can be another tool in university lectures that aim to build a positive attitude toward conquering demands that arise when living in a warming world.

Similar to the current study, broader national and international surveys show that public awareness of threats related to or caused by CW is generally high (Leiserowitz *et al.*, 2013; Leviston and Walker, 2012; Reser *et al.*, 2012). Yet, the proportion of students that were unaware that CW is currently underway was startling. A possible explanation could be that these students have a high psychological distance to current effects because of living in a metropolitan setting. Surveys targeting metropolitan and rural universities could help distinguish the impact of location on psychological distance to CW.

The authors agree with Walther *et al.* (2005, p. 649) that "scientists need to get more closely involved in opinion-forming to influence more effectively future climate change decisions made by politicians and policymakers". It is necessary to add that it appears equally important to disseminate scientific knowledge not only to the current but also to the next generation of decision-makers – our university students. Incorporating findings from psychological research on effects of CW on human wellbeing (Clayton *et al.*, 2015) into university curricula to foster positive attitudes, rather than fear of the future of students should be promoted. Concepts to future-proof higher education are readily available (Cortese, 2003; Davison *et al.*, 2014; Remington-Doucette and Musgrove, 2015). Results of the present study underpin two facts about university students in Australia:

(1) They feel powerless.

(2) They see the experts as the most credible source for information on CW.

The first fact has the potential to obstruct timely implementation of adaptation and mitigation strategies. The second fact opens opportunities to deliver novel lectures that engage students in developing necessary skills to become tomorrow's leaders in their respective disciplines, with strong grounding in efficacy in promotion of sustainability.

4.2 Possible shortcoming of the study

If survey participation alone can be used to interpret the level of engagement with the wider topic of climate change, our low response rate would indicate very low interest by the student community of WSU. This stands somewhat in contrast to findings by Feldmann *et al.* (2010) that show high engagement of young people in the topic. Possible explanations of our low return rate include *survey fatigue* (students regularly receive invitations to participate in surveys), *topic fatigue* (omnipresence of CW in mainstream media leads to reduced interest) or plain apathy. In addition, "Ecophobia" (i.e. prevention of action against CW because the enormity of the problem is overwhelming; *sensu*, Sobel, 2007) could have also contributed to the active decision of students to not participate in the survey. Currently, the authors are unable to discern the actual reason.

5. Conclusions

CW is happening today and will irreversibly continue to affect human life. Arguably, today's university students show the greatest potential to become tomorrow's

sustainability leaders of society. In their future roles, they should have the motivation and capacity for critical thinking to initiate action for limiting, mitigating and adapting to CW. The present study shows that awareness of problems associated with CW in this group of (mostly) young people is high, yet so is their feeling of incapacity. The arguably low response rate of the survey calls for careful interpretation, yet the clear combination of low factual knowledge paired with widespread despondence was pervasive. Based on findings of this study, educators should consider age- and gender-related differences in the perception of CW effects when developing and delivering effective teaching that aims to promote the principles of sustainability and environmental competency. For a considerable proportion, it is we, the academics that should provide students with the right tools to engineer their future. However, together, we co-construct knowledge by engaging in a process of reciprocity – as we, the teachers are as much students, as the students are teachers. The survey results document that today's students require tertiary education that reduces apparent empathy and psychological distance to effects of CW. Possible ways forward include expanding offers on interdisciplinary courses, and practical, real-world scenario analyses with emphasis on systems thinking. Student surveys, similar to the one used here, can provide a positive stimulus for development of such novel coursework.

Broadcasting survey results can generate interest by students in the topic. This is owed to the aforementioned mechanism of using negative emotions – like fear and sadness – to instigate more open-minded processing of information. Using a unified survey format across universities would enable assessment of sustainability attitudes and motivations between metropolitan and rural students. If academia wants to sufficiently prepare the next generation of sustainability stewards, it must address these blind spots in higher education. Scientists lecturing in topics related to CW and sustainability education may have an arduous way ahead (Wood *et al.*, 2016), and so do the students.

Note

1. The term *climate warming* is used here to circumvent increasing discussion on the use of terminology in climate change-related questionnaires (Schuldt *et al.*, 2015). Previous studies generated evidence that "climate change" is often understood as a natural phenomenon that has no personal commitment attached, whereas "global warming" is more personal, caused by human activity and associated with real events like melting of polar ice (Whitmarsh, 2009a).

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Further reading

Leiserowitz, A. and Smith, N. (2013), "The role of emotion in global warming policy support and opposition", *Risk Analysis*, Vol. 34 No. 5, pp. 937-948.

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