

Omani pre-service science teachers' views about global warming: Beliefs about actions and willingness to act

Abdullah Ambusaidi • Edward Boyes • Martin Stanisstree • Neil Taylor

Received 23 July 2011; Accepted 22 February 2012

A 44-item questionnaire was employed to determine pre-service teachers' beliefs about how useful various specific actions might be in helping to reduce global warming, their willingness to undertake these same actions, and the extent to which these two might be related. The instrument was administered to pre-service science teachers (n=104) at the Sultan Qaboos University in the Sultanate of Oman. The findings indicate that the majority of these Omani pre-service science teachers believed that global warming and associated climate change is happening now and they are concerned about it. Furthermore, they are aware of the measures that individuals could take to help ameliorate this problem but, despite this, showed a lack of willingness to act in key areas, such as the use of public transport and the purchase of smaller more fuel-efficient cars. This suggests that although the pre-service teachers appear to have a sound understanding of the actions that will help to reduce global warming and are well positioned to inform their students about these, their potential as role models might be compromised if their own actions are not in line with their understanding.

Key words: beliefs, climate change, environmental education, global warming, willingness, oman, pre-service teachers, science education

Introduction

Research undertaken by the Arab Forum for Environment (AFED) (2009) and Mahmoud (2009) indicate the possible effects of global warming on both Arab countries in general and Oman in particular. Arab countries may experience high negative impacts of climate change due to a reduction in freshwater supply, declining food production, sea level rise, diminishing biodiversity and worsening human health (AFED, 2009). For example, whilst regions close to Yemen may experience increased precipitation, rainfall may decrease in some coastal regions of Oman (Husain & Chaudhary, 2008). The latter could cause water shortages (El-Quosy, 2009) and this may ultimately result in political consequences (Freimuth, Bromberg, Mehyar & Khateeb, 2007). Climate change is also likely to impact negatively on agriculture, livestock, fishing and aquaculture (Abou Hadid, 2009).

Thus, countries in the Middle East and Gulf, such as Oman could be impacted quite dramatically by global warming and subsequent climate change if greenhouse gas emissions are not significantly reduced. Skamp, Boyes, and Stanisstree (2007) argue that although reducing

greenhouse gas emissions is a government, corporate, and community responsibility, individuals also have a role to play.

Theoretical Considerations

A key part of any integrated approach to ameliorating climate change must be education, both formal and non-formal, because it can be argued that if individuals are to make informed lifestyle choices that may impact climate change, they need some understanding of this phenomenon and the factors that contribute to it. However, early assumptions that knowledge alone would produce more environmentally sympathetic behaviour on the part of individuals have proven difficult to establish. While some studies have indicated that there is such a link (Yencken, 2000), many others have suggested that this connection is often tenuous (e.g. Hungerford & Volk, 1990) and in fact there can be a 'gap' between cognition and action (Kollmus & Agyeman, 2002). The difficulty in establishing a link between knowledge and behaviour in relation to the environment may occur because of the many factors that interact with environmental knowledge, and thereby weaken the direct linkage between knowledge, attitude and action (Rodriguez, Boyes & Stanisstreet, 2010). Previous studies have been rather general in their approach to the environment, dealing with broad of issues rather than a single focus (e.g. Yencken, Fein & Sykes, 2000). Furthermore, it has become clear, as workers have attempted to generate models of the drivers of environmentally sympathetic behaviour, that there are limitations in studying links between environmental beliefs and attitudes in general and potential behaviour patterns (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Dietz, Stern & Guagnano, 1998; Stern, 1992).

The present study, undertaken with pre-service science teachers in the Sultanate of Oman, attempts to address part of this problem by employing a survey instrument focusing on specific environmental behaviours, and beliefs about the possible effects of these particular actions on the amelioration of one major environmental problem - global warming.

Context and Sample

The Sultanate of Oman is located in the south-east of the Arabian Peninsula. It has borders with three other Arab countries - the United Arab Emirates, Saudi Arabia, and Yemen. It has a middle-income economy that is heavily dependent on oil resources. Because oil reserves are now dwindling, the country's political leadership has actively pursued a development plan that focuses on diversification, industrialization, and privatization, with the objective of reducing the oil sector's contribution to GDP to 9% by 2020. Per capita income was estimated at US\$25,600 in 2010 (CIA World Factbook, 2011). Tourism and gas-based industries are key components of the government's diversification strategy.

The population of Oman is approximately 3 million, and is growing rapidly at a rate of approximately 3.1% per annum, with 43% of the population being under 15 years of age. Oman is heavily dependent on migrant labour from South Asia and the Philippines, with more than half a million migrants estimated to be working in largely relative low paid unskilled jobs (CIA World Factbook, 2011). However, with the rapidly growing local population there is now a strong move toward 'Omanization' of the workforce with Omani young people taking on jobs previously done by migrant labourers.

In environmental terms, Oman is a signatory to a number of important environmental conventions and the ruling Sultan views conserving the environment as a priority. Environmental education is well integrated into the school curriculum in Oman. At the secondary level this occurs particular as part of science and social studies. Furthermore there is explicit content

about global warming in the social studies curriculum for grade 10 (for a comprehensive account of environmental education in Oman see Ambusaidi & Al-Rabaani, 2009).

The study sample comprised 104 pre-service secondary science teachers representing the entire 3rd and 4th year cohort from the College of Education of Sultan Qaboos University in Oman; all of the participants were undertaking a 4-year Bachelor Degree in Education. This research followed an earlier study that employed the same instrument with secondary level students in Oman (Ambusaidi, Boyes, Stanisstree, & Taylor, 2012). Teachers' understanding and beliefs are important because they can influence many generations of young people who will become decision-making adults. According to Said, Ahmadun, Paim and Masud (2003) teachers are instrumental factors in the formation of student beliefs and as such, their views about environmental issues are significant. So it was of interest to gain some insight into teachers' views and also compare these with those of their students.

Aim of the Study

The study was initiated in the UK, but has since been extended to a number other countries; here we report the findings of a study of pre-service science teachers in the Sultanate of Oman. The aims of the research were to address a number of research questions:

- (1) To what extent do Omani pre-service teachers intend to undertake a variety of specific actions to conserve the environment? This was designated respondents' Degree of Willingness to Act.
- (2) To what extent do the pre-service teachers believe that these same actions would be effective in reducing global warming? This was designated respondents' Believed Usefulness of Action.
- (3) What relationships exist between the pre-service teachers' willingness to undertake specific actions and their belief about the usefulness of these actions?

A series of novel indices were constructed to quantify these relationships. In addition, certain tentative comparisons were made with a study on secondary students in Oman using the same instrument (Ambusaidi, et al., 2012).

Methodology

Questionnaire Design and Administration

This study used a closed-form questionnaire that was originally developed for use in the UK (Boyes, Skamp & Stanisstree, 2009). Before its use in the Omani context, the questionnaire was translated into Arabic and then back-translated, independently, into English. The back-translated version of the questionnaire was scrutinised by native English speakers, to ensure the integrity of the translation. At the same time the content validity of the instrument was examined for use in its new context; on the basis of this a number of items were changed slightly. For example, the wording of the item "Even though it cost me money, I would make changes to my home to stop so much heat escaping" became "...to stop so much heat entering". Furthermore, since there are no taxes in Oman, items referring to taxes had the word 'money' placed in brackets to help clarify this concept. Finally, the word "politician" was replaced with "Shora Council Member" to better reflect the political context in Oman.

The questionnaire was arranged in number of sections. The coversheet asked the pre-service secondary teachers to record their gender and subject specialisation, that is, Biology

Chemistry or Physics. The first major section of the questionnaire then asked the pre-service teachers about their intentions to act in environmentally sympathetic ways or, in the words of the introduction to the questionnaire, “things you might do for the sake of the environment and future of the Earth”. At this point in the survey, there was no mention of global warming. The items in this section each had conditional phrases in them, such as “Even if it took me longer and was more inconvenient, I would try to use buses and trains instead of a car”. These items were to determine what was designated students’ Degree of Willingness to Act. There were 20 such items in this section of the survey; four were distracter items (actions that would not, in reality, reduce global warming), and the remaining 16 concerned actions that are generally accepted as having some effect in reducing global warming. The wording of the items in this section can be seen in the left hand column of Table 1. The second main section of the questionnaire probed pre-service teachers’ beliefs the extent to which specific actions or patterns of behaviour would contribute to a reduction in global warming; these items were to determine pre-service teachers’ Believed Usefulness of Action. There were also 20 items in this section, and these were paired with the items in the first section. For example, the item above was paired with the question “If people didn’t use their cars so much, Global Warming would be reduced...”. The wording of the items in this section can be seen in Table 1. In the actual questionnaire, the items in the first and second major sections were in different orders so that the pairing would not have been immediately obvious to the respondents.

These items were chosen to provide a reasonably comprehensive coverage of the things that could, to varying degrees, reduce global warming. Although it was not an exhaustive list, the actions were considered to be representative and are generally accepted as important (US EPA, 2010). Most of the ideas in these items were related to carbon dioxide emissions from energy use and wastage, although two were concerned with other greenhouse gases, methane and nitrogen oxides. Four of the 16 items were concerned with indirect actions, such as supporting increased environmental taxation or legislation.

The possible responses to the items in the two main sections of the questionnaire, and the ways in which they were scored are shown in Table 2. Here it can be seen that, just as the items in the two sections were covertly paired, so the wording of the response options was designed to be semantically matched in such a way that a person’s willingness to act seemed reasonable in light of their belief. This allowed a measure of the relationship between the degree to which a respondent would be likely to take an action and the extent to which they believed it had a beneficial effect in reducing global warming.

For further discussion of the theory underpinning the development of the survey instrument see Boyes and Stanisstreet (2011), Boyes, Skamp and Stanisstreet (2009) and Skamp, Boyes, and Stanisstreet (2007).

Here the items in the two main sections of the questionnaire have been arranged in their pairs, to demonstrate the ways in which they correspond. In the actual questionnaire the items within each section were in random order, apart from the last four items, those about voting and education.

Analysis of Results and Construction of Indices

The responses were scored and entered into an SPSS data file for analysis. The distributions of responses for the Degree of Willingness to Act and Believed Usefulness of Action for the different actions were calculated. Next, differences between the distributions of responses between male and female pre-service teachers, between different discipline cohorts (Biology, Chemistry and Physics), and between pre-service teachers and Omani school students (Ambusaidi et al, 2012) were investigated using Chi Squared analysis, with $p < 0.05$ as the critical value.

Table 1. Wording of the survey items in the two main sections of the questionnaire

Degree of Willingness to Act (How likely is student to undertake action?)	Believed Usefulness of Action (To what extent would action ameliorate global warming)
Even if it was not as fast or luxurious, I would try to get a car that uses less petrol or less diesel	If people had smaller cars that used less petrol or less diesel, Global Warming would be reduced
Providing more of our energy was produced from nuclear power stations, I would be willing to pay more for electricity	If more of our energy was produced from nuclear power stations, Global Warming would be reduced
Even though it cost me money, I would make changes to my home to stop so much heat escaping	If people made changes to their homes to stop so much heat escaping, Global Warming would be reduced
To save electricity, I would switch things off at home when I didn't need them	If people used less electricity in their homes, Global Warming would be reduced
Even if I had to pay more taxes, I think there should be more trees planted in the world	If more trees were planted in the world, Global Warming would be reduced
Even if it was more trouble for me, I would recycle things rather than just throw them away	If people recycled things more, Global Warming would be reduced
Even if it was more expensive, I would buy food grown without the use of artificial fertilisers	If farmers stopped using artificial fertilisers with nitrogen in them, Global Warming would be reduced
Even if it meant that I didn't always have the latest 'gear' or fashion, I would be prepared to buy new things less often	If people were prepared to buy fewer new things and make do with the old ones, Global Warming would be reduced
Providing more of our energy was produced from the wind and waves and sun, I would be willing to pay more for electricity	If more of our energy was produced from the wind, waves and sun, Global Warming would be reduced
Even if it took me longer and was more inconvenient, I would try to use buses and trains instead of a car	If people didn't use their cars so much, Global Warming would be reduced
Even if I really liked meat, I would eat fewer meals with meat in them	If people eat less meat, Global Warming would be reduced
Even if it cost me more, I would buy things for my home (like fridges and washing machines) that use less energy	If people got things for their homes (like fridges and washing machines) that used less energy, Global Warming would be reduced
I would vote for a politician who said they would bring in laws to help the environment, even though it might stop me doing some of the things I really enjoy	If politicians made the right kind of new laws, Global Warming would be reduced
I would vote for a politician who said they would increase taxes to pay for things that would help the environment, even though it meant me having less money to spend	If politicians made people pay more tax and spent the money on the right kind of things, Global Warming would be reduced
I would vote for a politician who said they would sign agreements with other countries to help the environment, even though I might have to change the way I live	If there could be more agreements between different countries about not putting certain gases into the air, Global Warming would be reduced
I would like to learn more about helping the environment, even though it would mean extra work for me	If people were taught more about it, Global Warming would be reduced

Table 2. Wording and scoring of the responses

Degree of Willingness to Act (how likely is student to undertake action?)		Believed Usefulness of Action (to what extent would action ameliorate global warming?)	
Semantic descriptor	Score	Semantic descriptor	Score
Definitely	1.00	By quite a lot	1.00
Almost certainly	0.75	By a fair amount	0.75
Probably	0.50	By a small but useful amount	0.50
Perhaps	0.25	By a small amount – hardly noticeable	0.25
Probably not	0.00	By nothing at all really	0.00

Following this, various indices were calculated to determine the relationship between students' Degree of Willingness to Act and their Believed Usefulness of Action. Although the two response scales are ordinal and although they measure different things, it was felt that because of their semantic matching (Table 1), some mathematical manipulation of the data was acceptable.

First, the Believed Usefulness of Action score was subtracted from the Degree of Willingness to Act score for each pair of items. This provided an index, designated the Environmental Friendliness Coefficient that can have a value between -1 and +1. As the two sets of responses had been semantically matched, this index provides, for each action and for each respondent, a measure of the alignment or discrepancy between beliefs about the extent to which a student believes an action would alleviate global warming and their willingness to take that action. Thus, values close to zero indicate that the intended action of a respondent was approximately consistent with their belief about the effectiveness of that action. A positive value means that they intend to do more than might be expected from their belief; a negative value means that they are only willing to do less. Thus, this index is a measure of 'responsiveness' to different actions. It is likely, therefore that those actions with positive scores are those regarded by pre-service teachers as being relatively convenient or uncostly, whereas those with negative scores are viewed as less convenient or more costly in some way.

The second index to be calculated for each action was the Potential Effectiveness of Education. This was done by plotting the scores for the Degree of Willingness to Act for a particular action against the scores of the Believed Usefulness of Action for the same action, and then fitting a regression line. The slope of the line can be considered to be a measure of the Potential Effectiveness of Education because it indicates the amount by which strengthening respondents' beliefs that an action is effective might increase their willingness to undertake that action. An action that produces a steep gradient on the regression line will be more likely to respond positively to educational input than one with a shallow gradient, and it could be argued that education about global warming might be best targeted at those actions with a steep slope. A graph illustrating a hypothetical example of this procedure is shown in Figure 1.

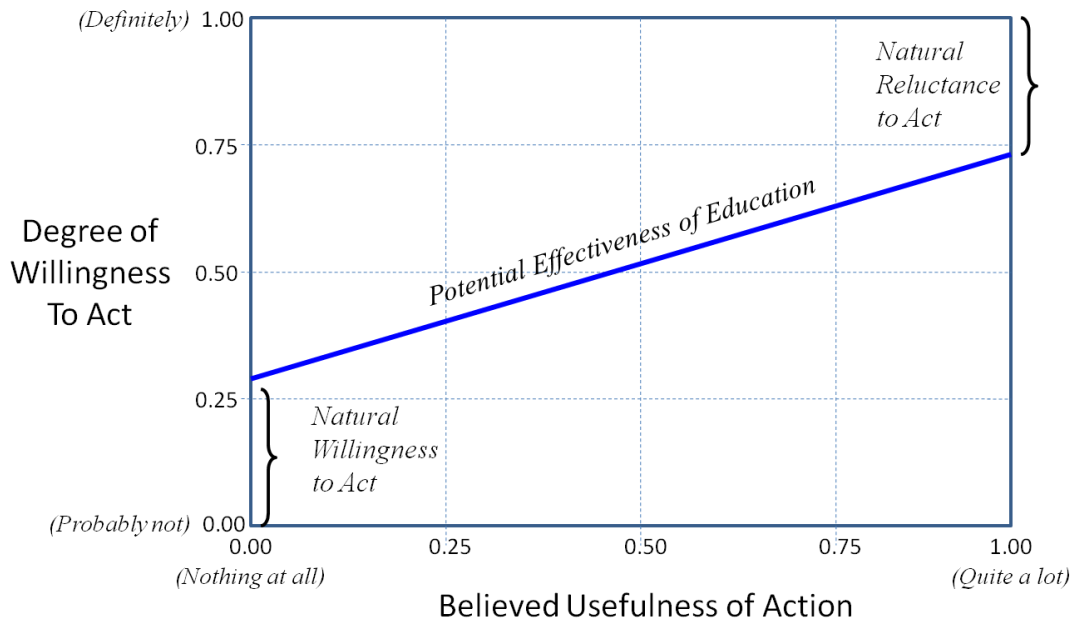


Figure 1. Schematic plot of values for Degree of Willingness to Act against Believed Usefulness of Action

From Figure 1 it can be seen that this method produces two other indices, which we have designated the Natural Willingness to Act and the Natural Reluctance to Act. The former index represents the extent to which respondents would be likely to undertake an action even when they believe that it is not at all effective in reducing global warming; the latter indicates the extent to which they may not undertake an action even if they believe it is highly effective.

Findings

The following section reports the findings of the study with pre-service teachers. A similar study using the same questionnaire was undertaken in Oman with 1532 secondary school students in Years 6-12 and has been reported previously by Ambusaidi et al (2012) and some of these results are compared with those of the pre-service teachers in the sections below. For such comparisons, and for comparisons of the responses of different subsets of the pre-service teachers cohort, only statistically significant differences are reported.

For the present study, the sample comprised 104 pre-service secondary science teachers from the College of Education of Sultan Qaboos University in Oman. All of these participants were undertaking a 4-year Bachelor Degree in Education specialising in one of the three major areas of science, Biology (53% of the cohort), Chemistry (33%) or Physics (14%). The sample comprised a mix of 3rd (57%) and 4th (43%) year students, and included male (36%) and female (64%) students.

Pre-service Teachers' Self-Perceptions

The final section of the questionnaire contained four items. The first asked the Omani pre-service teachers about their level of concern about the adverse environmental effects of global

warming; here the possible responses were “I am very worried”, “I am quite worried”, “I am a little bit worried” and “I am not worried at all”. The next item asked students how much they thought they knew about global warming, with “I know a lot about global warming”, “I know something...”, “I know a little...” and “I know almost nothing...” as available responses. The third item in the last section asked students to estimate their own level of environmental ‘friendliness’; the responses here were “I am very environmentally friendly”, “I am quite...”, “I am a bit...” and “I am not at all...”. Finally, students were asked whether or not they thought global warming is really happening now, with “I am sure global warming is happening”, “I think...”, “I don’t know whether global warming is happening or not”, “I think global warming is not happening” and “I am sure global warming is not happening” as possible responses.

Almost the entire cohort of pre-service teachers (95%) believed (were either ‘sure’ or ‘thought’) that global warming was happening at present, with no significant differences between the responses of male and female participants or between those of the subject majors of Biology, Chemistry and Physics. The pre-service teachers also exhibited considerable concern about global warming with 89% indicating they were either ‘very’ or ‘quite’ worried about global warming. About three quarters (74%) of the group thought they were knowledgeable about global warming, while 91% considered themselves ‘very’ or ‘quite’ environmentally friendly. Again there were no statistically significant gender or discipline-based differences in the responses to these items.

These findings for the pre-service teachers were very similar to those for the cohort of Omani secondary school students who also completed the instrument (Ambusaidi et al, 2012), although only 80% of secondary students perceived global warming as happening now, compared to 95% of the pre-service teachers.

Pre-service Teachers’ Degree of Willingness to Act

Pre-service teachers’ responses to the items in the section of the questionnaire designed to probe their Degree of Willingness to Act are summarised in Table 3. In the descriptions below, the proportions of participants given are for those who reported that they would ‘definitely’ or ‘almost certainly’ undertake the action; for brevity, this is described below as ‘being willing’ or ‘being prepared’ to undertake an action.

The Omani pre-service teachers generally appeared willing to take those pro-environmental actions that might be considered to be of minimal inconvenience. Thus, the highest ranked response with 96% was a willingness to switch off un-used devices at home. A large majority also appeared willing to pay for the planting of more trees (84%) with a significant difference between the responses of males and females (72% and 91% respectively), get more efficient domestic appliances (79%) and install home insulation (75%). It was interesting to note however, that 71% appeared to be willing to buy fewer things which, in an affluent society like Oman with a relatively high per capita income, could be considered a personal inconvenience or ‘cost’. This also contrasted quite markedly with the response from the Omani secondary school cohort indicating that only 54% were willing to buy fewer things (52% believed this action to be useful). This difference between pre-service teachers and secondary students may be the result of the difference in age demographic and the greater pressure that adolescents experience to buy more, or it may arise because younger people are less aware of connection between consumption and global warming.

Table 3. Omani pre-service Teachers' Degree of Willingness to Act and Believed Usefulness of Action for specific actions

	Degree of Willingness to Act (% 'Definitely' + 'Almost certainly')	Believed Usefulness of Action (% 'Quite a lot' + 'A fair amount')
Direct actions		
Switch off un-used devices at home	96	63
Plant more trees	84	92
Get more efficient domestic appliances	79	71
Install more home insulation	75	40
Buy fewer new things	71	55
Recycle more things	66	75
Use artificial fertilizers less	65	69
Make more energy from renewable sources	61	89
Eat less meat	58	23
Use smaller, more fuel-efficient cars	32	74
Make more energy from nuclear power	27	66
Use public rather than private transport	22	80
Indirect actions		
More education	83	83
Vote for pro-environmental legislation	76	61
Vote for pro-environmental international agreements	74	91
Vote for pro-environmental taxation	40	66

Items have been arranged in descending order of percentages of the top two categories of response ('Definitely' + 'Almost certainly') for respondents' Degree of Willingness to Act.

In contrast, the item probing the willingness to use smaller, more fuel-efficient cars indicated a less favourable response from the pre-service teachers; fewer pre-service teachers (32%) were willing to take this action than secondary students (48%). In this case it is possible that the teachers, most of whom would already be driving, felt less inclined to make this sacrifice than school students, still unable to drive themselves. Certainly, because of the low cost of petrol and limited duty or tax on vehicles, many Omani citizens drive large sports utility vehicles. These may be perceived as more comfortable and safer than smaller cars and, given the low financial running costs, it may well be that those familiar with the realities of driving would be less inclined to 'down-size'.

The willingness to use public rather than private transport was also low amongst pre-service teachers at 22%, with a marked difference between males (36%) and females (14%). The gender difference exhibited in this response is probably linked to socio-cultural issues, as females in Oman are general less likely than males to travel unaccompanied. However, the

overall reluctance to use public transport may be related to the relatively uncomfortable nature of public transport in Oman, which generally takes the form of a system of minibuses that are often overcrowded and used almost exclusively by migrant workers from the Indian sub-continent and less affluent Arab countries. It was interesting to note, however, that secondary students appeared more willing to use public transport (32%) than the pre-service teachers (22%).

Most forms of indirect action, including education (83%), legislation (76%) and international agreements (74%) were strongly supported by the pre-service teachers, although education was supported by fewer male (72%) than female (89%) respondents. The exception to the generally strong backing for indirect actions was pro-environmental taxation, in that only 40% of pre-services teachers indicated a willingness to support this. This is consistent with the tendency to show willingness in those areas of life that require little personal inconvenience, since taxation involves a much more direct financial cost to an individual than the other three actions in this group. This trend was also apparent with the school age cohort that was largely supportive of indirect actions at over 60%, but where only 46% of the school students showed support for extra taxation.

Pre-service teachers' Believed Usefulness of Action

The responses to the items in the second main section of the questionnaire, designed to probe students' Believed Usefulness of Action, are also summarised in Table 3. In the descriptions below, the proportions of students given are for those who believed that an action would reduce global warming by 'quite a lot' or by a 'fair amount'.

The direct actions perceived to be the most effective for reducing global warming were planting trees (92%), making more energy from renewable sources (89%) and using public transport (80%). Other actions with high ratings included increasing cycling (75%), using smaller cars (74%) and getting more efficient domestic appliances (71%). About two-thirds of the cohort believed that global warming would be reduced by using artificial fertilizer less (69%), making more energy from nuclear power (66%) and switching off devices at home (63%). In fact only two direct actions registered less than fifty percent in this scale, the ideas of installing more home insulation (40%) and eating less meat (23%). This final item was also ranked lowest by secondary students at 32% and this finding may indicate a lack of understanding of the impact of livestock production on greenhouse gas emissions. Furthermore, it is possible that, despite a science background, these pre-service teachers may have equated insulation with keeping heat in rather than keeping it out. International agreements and education (91% and 83% respectively) were viewed as the more effective indirect actions to combat global warming, with taxation (66%) and legislation (61%), considered rather less effective.

There were significant differences between the responses of the male and female respondents for three items, those concerning planting trees (males 78%, females 100%), increasing recycling (61%, 82%) and reducing the use of artificial fertilizers (57%, 76%). In each case females considered these items more useful than did males.

Although there were similarities in the overall ranking of actions in terms of their perceived contribution to reducing global warming between pre-service teachers and secondary students, in general the teachers showed more inclination to rank actions higher. This was particularly marked for the actions concerning making more electricity from renewable energy sources (89% of pre-service teachers, 64% of school students) and increasing recycling (75% of pre-service teachers, 55% of school students).

Environmental Friendliness Coefficients

The values of the Environmental Friendliness Coefficients for each pair of items are presented in Table 4.

Table 4. Indices to demonstrate the quantitative relationships between Omani pre-service science teachers' Degree of Willingness to Act and the Believed Usefulness of Action for specific actions

	Median Environmental Friendliness Coefficients	Potential Effectiveness of Education	Natural Willingness to Act	Natural Reluctance to Act
Direct actions				
Eat less meat	0.25	0.38	0.50	0.12
Switch off un-used devices at home	0.25	0.06	0.91	0.03
Install more home insulation	0.25	0.08	0.69	0.22
Buy fewer new things	0.00	0.10	0.65	0.25
Get more efficient domestic appliances	0.00	0.05	0.76	0.20
Recycle more things	0.00	0.11	0.62	0.26
Plant more trees	0.00	0.20	0.66	0.14
Use artificial fertilizers less	0.00	0.13	0.59	0.28
Make more energy from renewable sources	-0.25	0.33	0.38	0.29
Make more energy from nuclear power	-0.25	0.30	0.20	0.51
Use smaller, more fuel-efficient cars	-0.25	-0.12	0.54	0.58
Use public rather than private transport	-0.50	0.13	0.20	0.68
Indirect actions				
Vote for pro-environmental legislation	0.25	0.18	0.64	0.18
More education	0.00	0.14	0.71	0.15
Vote for pro-environmental international agreements	0.00	0.21	0.56	0.22
Vote for pro-environmental taxation	-0.25	0.31	0.29	0.40

Items have been arranged in descending order of median Environmental Friendliness Coefficients.

The overall average for the Environmental Friendliness Coefficient for all students and all 16 actions was close to zero (-0.03), suggesting that the semantic matching of the two sets of items was reasonable for this cohort. For an individual action, an Environmental Friendliness Coefficient value close to zero indicates a strong degree of consistency between pre-service teachers' beliefs and their willingness to act; several actions such as planting more trees, increasing recycling, getting more efficient electrical appliances and using artificial fertilisers less had such values. Other actions had Environmental Friendliness Coefficients with higher values, indicating that pre-service teachers were more prepared to take the actions than their beliefs in their effectiveness in reducing global warming might warrant. Eating less meat, switching off un-used electrical devices and installing home insulation were actions of this type. In contrast, other actions had Environmental Friendliness Coefficients with values lower than zero, implying that pre-service teachers were less willing to undertake the actions than their belief might justify. Using public transport, using smaller private vehicles, and generating

energy from nuclear or renewable sources were actions that fell into this category. This would suggest that there are relatively strong disincentives to undertaking these particular actions. These findings are similar to the trends found in the cohort of secondary students who completed the same questionnaire (Ambusaidi et al, 2012).

Potential Effectiveness of Education

Values for the Potential Effectiveness of Education, the Natural Willingness to Act and the Natural Reluctance to Act indices, which were explained in relation to Figure 1, are also shown in Table 4. The values for the Potential Effectiveness of Education for all but one action (using smaller, more fuel-efficient cars) were positive, suggesting that increasing pre-service teachers' appreciation of the usefulness, in terms of reducing global warming, of any of the other actions might be partially effective in increasing their willingness to undertake them. However, many of the values of the Potential Effectiveness of Education were low; that is, the gradient of the regression line was shallow. For example, there appears to be little advantage in increased education about the importance of switching off un-used electrical devices, because the Potential Effectiveness of Education is very low. Examination of the data in Table 4 shows that this is because the Natural Willingness to Act is high; thus, pre-service teachers are already prepared to undertake this action. The value for the Potential Effectiveness of Education for using public rather than private transport was also relatively low. In this case, however, this was because the value of the Natural Reluctance to Act was comparatively high. Thus, even when pre-service teachers appreciate that using public rather than private transport can make an important contribution to reducing global warming they are still reluctant to do so. However, in certain cases the values for the Potential Effectiveness of Education were higher, suggesting that education in these areas could be beneficial in terms of reducing global warming. Specifically, eating less meat, making more energy from renewable sources and, separately, from nuclear sources were actions that fell into this category. In these cases, then, education that convinces more pre-service teachers about the usefulness of the actions in reducing global warming might prove effective in terms of changing pre-service teachers' practices.

For any group within a population, the extent to which education might be useful depends not only on the degree to which it might be effective for individuals but also on the relative size of the potential audience, that is, the proportion of pre-service science teachers who would not already take the action. This can be visualised by plotting the Potential Effectiveness of Education against the proportion of pre-service teachers who would 'probably not' or only 'perhaps' take that action; this plot is shown in Figure 2. Actions to the left of the graph are those with a relatively low Potential Effectiveness of Education, suggesting that even if more people were convinced, through education, of the usefulness of such actions for reducing global warming, they would not be willing to undertake them. For example, although 74% of pre-service teachers believed that using a smaller car would reduce global warming by 'quite a lot' or by a 'fair amount', there was a very low willingness to adopt this action and consequently little chance that more education about this action could make a difference to behaviour. In other words, the Potential Effectiveness of Education was small, and the data point for this action locates at the left hand side of the plot. In contrast, actions that lie to the right of the plot, those with a high Potential Effectiveness of Education, are actions for which education might convince respondents to increase their willingness to act. Support for the adoption of nuclear or renewable power sources are examples of this type of action. Actions that lie towards the bottom of the graph are those where only a small proportion of individuals are currently unwilling to undertake the action; here the cohort for having their behaviour changed is relatively small. In this case because willingness to take these actions is generally high, there is

limited need for education. The actions that appear in the upper part of the graph are those for which fewer individuals are already willing to undertake the action. Given these parameters, actions that locate in the upper, right hand region of the plot are those for which education might be most beneficial, in terms of behaviour change, on a population basis. Support for the adoption of nuclear power and a willingness to use public transport are examples of such actions.

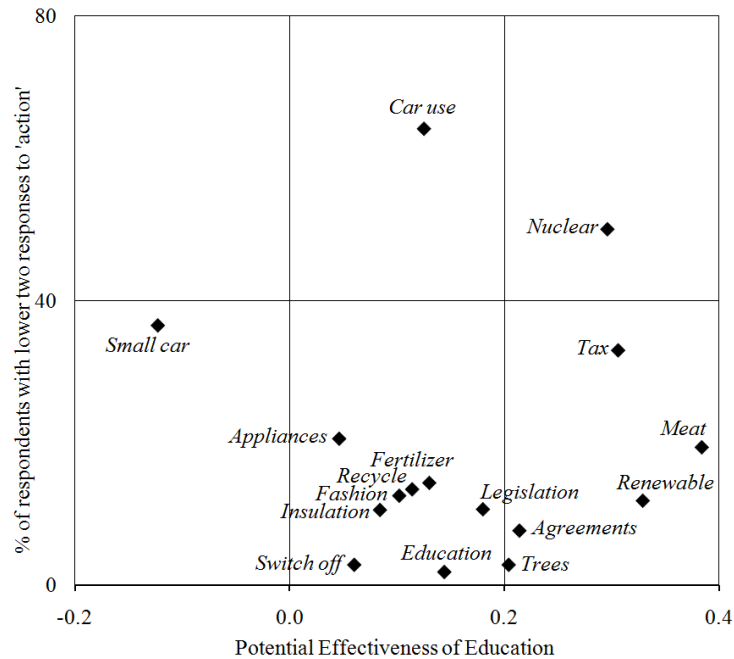


Figure 2. Scatter graph of Potential Effectiveness of Education (abscissa) and the percentages of Omani pre-service science teachers who would 'probably not' or only 'perhaps' undertake the action (ordinate).

Discussion

This study indicates that Omani pre-service teachers of secondary science have a strong belief that anthropogenic global warming is happening at the present time. This view seems widespread, in that there were no differences between the responses to this item of respondents from the three science disciplines (Biology, Chemistry and Physics) or between gender groups. The overall cohort also exhibited considerable concern about the phenomenon of global warming, and approximately three quarters of the study group felt that they were reasonably well informed about it. In this respect awareness of and concern about global warming was similar to that exhibited by secondary school students in Oman (Ambusaidi et al. 2012).

Thus an awareness of, and a concern about, global warming appears to develop early in youngpeople in Oman. This level of concern is also shown by young people in India (Chokkar, Dua, Taylor, Boyes & Stanisstree, 2011), whereas similar age groups in Australia (Boyes, Skamp & Stanisstree, 2009) and Spain (Rodriguez, Boyes & Stanisstree, 2010) appear less concerned. In part, this higher level of awareness and apprehension amongst Omani pre-service teachers and secondary students might be because the Sultan of Oman and his government are concerned about environmental problems and have put in place a number of strategies to protect

the environment, most recently, by forming the Ministry of Environment and Climate Affairs (Ambusaidi & Al-Rabaani, 2009).

This was largely borne out by their responses to the Believed Usefulness of Actions items that indicated, with a few exceptions, that they were clear about the impact of certain actions on global warming. Almost all of the pre-service teachers viewed themselves as being 'environmentally friendly' and more than three-quarters believed that education had a key role to play in ameliorating global warming; it is reassuring, then, that those who will become teachers are convinced of the practical value of environmental education.

In contrast, it was somewhat disturbing to find in many cases that, although the pre-service teachers understood cause and effect in respect to global warming, they often demonstrated reluctance actually to take actions that they were aware would have a positive impact in this regard. On two key actions, for example, using public transport and driving smaller cars, only about a quarter and a third of the respondents respectively indicated that they would be willing to take action. These proportions were lower than those for the students that they might ultimately teach. Furthermore, only less than half of the pre-service teachers indicated a willingness to pay pro-environmental taxes, again marginally lower than secondary students in Oman.

There are some factors that may explain the disparity between belief in the efficacy of an action and a willingness to undertake it in these key areas. Public transport in Oman is not particularly well developed, comprising fleets of minibuses, often ageing, that are often hot and over-crowded. These are mainly used by the large number of migrant workers, mainly from the Indian sub-continent, employed in Oman. Furthermore, Oman is a very car-orientated society. Cars in general are relatively inexpensive because they incur no duty or tax, and are often purchased at even lower prices in neighbouring United Arab Emirates such as Dubai and Sharjah. Running costs are also comparatively economic due to the low cost of fuel, partly because fuel is not imported or taxed. In addition, the road network between the major centres is excellent, with relatively low volumes of traffic. As a consequence, many Omanis can afford to drive large, air-conditioned, four-wheel-drive vehicles even though they may consume considerable amounts of fuel and thus emit relative large amounts of carbon dioxide. Furthermore, the average family size is relatively large in Oman, with most families having four or more children, so bigger vehicles may be seen as a necessity, not just a luxury. Overall, then, in temperatures that often exceed 40 degrees Celsius in summer, individuals may be reluctant to drive smaller less comfortable vehicles.

The dissonance among pre-service teachers between belief in the efficacy of action and a willingness to undertake it may present a problem if education is to play a significant role in behaviour change. Teachers may well understand many of the actions necessary to ameliorate global warming and be able to communicate these to their students. However, teachers can also act as role models in a variety of educational settings (Paice, Heard & Moss, 2002), including environmental education (Sivek, 2002). Nevertheless, if teachers are willing to undertake only those actions that involve minimal personal cost (such as switching off un-used domestic appliances) and are unwilling to undertake those that involve personal inconvenience (such as driving smaller cars), then their potential as role models for pro-environmental behaviour may be compromised. Students may be confused when their role models argue one standpoint but behave in a contrary manner (Paice, Heard & Moss, 2002). Unfortunately, as the scatter graph indicates, the potential for education of pre-service teachers themselves in this area is low because they are already aware of the appropriate actions.

One key to changing behaviour about personal transport may be to offer palatable alternatives, such as a more efficient and comfortable public transport system. In this way, some of

the physical inhibitors (Corraliza & Berenguer, 2000) to using public transport may be reduced. This might also apply to other actions such as supporting energy from renewable sources. This action was correctly viewed by the majority of pre-service teachers as being useful in ameliorating global warming, yet less than a third appeared to be willing to support this strategy. In part this may be due to a lack of experience, since at present there is little evidence of renewable energy generation in Oman either on a large industrial scale or at personal level via solar panels fitted to individual homes. Given the climatic conditions in Oman, which is predominantly within a desert region with very high levels of sunshine and minimal cloud cover, the country is well placed to develop solar energy sources. This would seem to be prudent direction for the government to take even on purely utilitarian grounds because Oman's limited oil reserves are becoming exhausted and the government is attempting to reduce its dependency on these reserves as an income stream. In this particular instance then, it could be that political aims, financial drivers and environmental considerations become aligned. That this currently is not the case may go a long way towards explaining the dissonance in the respondents' views that limit overall the personal cost they are prepared to pay to reduce Oman's contribution to global warming.

Indeed, it appears that the government of Oman may now be moving in this direction because the Omani General Authority for Electricity and Water has commissioned a study on the potential for renewable energy in Oman, and the final report was published in May, 2008 (Authority of Electricity Regulation, Oman, 2008). On the basis of this report, the Authority for Electricity Regulation has shortlisted six renewable energy pilot projects involving both solar and wind generation. The six shortlisted projects, if implemented, would replace 11GWh of annual diesel generation with renewable-sourced electricity. This is expected to reduce diesel fuel consumption by 3.1 million litres per year and avoid the production of nearly 8,300 metric tons of carbon dioxide per year.

The other two areas where education could make a significant impact, according to the findings of this study, relate to nuclear power and eating meat. Regarding the former, the prospect seems unlikely. Although the Government of Oman has been in communication with the Nuclear Power Agency, the establishment of a nuclear industry would be an extremely expensive exercise. Furthermore, the recent events in Japan (which occurred after this study), with the very severe damage to the Fukushima nuclear plant and the subsequent response of the German government with its commitment to close down all its nuclear power stations, make it unlikely that Oman will pursue this energy option. Thus, any education in this area can have no impact, as it will not be accompanied by choice. In contrast, meat is a significant part of the Omani diet and educating people about the link between livestock production and the generation of methane may have some impact on behaviour, because in this aspect there are other options and choice of diet is, to some extent, under personal control.

Conclusion

We are aware that, as Cialdini, Renoand and Kallgren (1990) argue, simply improving individuals' understanding of the root causes of an environmental issue such as climate change does not necessarily result in any change in behaviour, as many factors can influence whether or not a person acts in an environmentally sympathetic fashion. However, it would be difficult to argue that if individuals are to make informed choices in relation to the environment, then such knowledge is a prerequisite. Furthermore, there is a clearly risk in relying too much on individuals' declared intentions to act, because intentions may not translate into actual behaviour. Having said this the study was encouraging insofar as it indicated that the present

cohort of pre-service secondary science teachers appears to be well informed about the factors that lead to increased emissions of greenhouse gases. This indicates that they are well placed to make informed decisions and pass this information on to their students once they begin teaching. However, their own commitment to adopt these behaviours appeared questionable particularly where these involved personal cost. This may in part be due to a lack of available opportunities. Certain changes to infrastructure in Oman, such as the proposed trialling and implementation of renewable energy projects involving solar- and wind-powered electricity generation, may broaden choices and provide opportunities for changed behaviour.

References

- Abou Hadid, A.F. (2009). Food production. In M.K. Tolba, & N.W. Saab (Eds.), *Arab environment climate change: Impact of climate change on Arab countries 2009 report of the Arab forum for environment and development* (pp 63-74). (<http://www.afedonline.org/afedreport09/english/Char5.pdf>; accessed July 2010)
- AFED (Arab Forum for Environment and Development) (2009). *Recommendations of the AFED Conference on Climate Change, 24 November 2009*. (<http://www.afedonline.org/en/inner.aspx?contentID=437>; accessed June 2010)
- Ambusaidi, A. & Al-Rabaani, A. (2009) Environmental education in the Sultanate of Oman: Taking sustainable development into account. In N. Taylor, M. Littledyke, C. Eames, & R. K. Coll, (Eds). *Environmental education in context: an international perspective on the development of environmental education* (pp. 39-50). Rotterdam: Sense Publishers.
- Ambusaidi, A., Boyes, E., Stanisstreet, M., & Taylor, N. (2012). Students' views about global warming in Oman: Beliefs about actions and willingness to act. *International Research in Geographical and Environmental Education*, 21(1), 21-39.
- Authority of Electricity Regulation, Oman, (2010). Press release: Electricity regulator announces renewable energy pilot projects shortlist (http://www.aer-oman.org/index.php?option=com_content&view=article&id=146; accessed July, 2011)
- Authority of Electricity Regulation, Oman (2008). *Study on renewable energy resources, Oman. Final report*. (http://www.aer-oman.org/index.php?option=com_content&view=article&id=146; accessed July, 2011)
- Ajzen, I. & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour*. Englewood Cliffs: NJ, Prentice Hall.
- Boyes, E. & Stanisstreet, M. (2011). Environmental education for behaviour change: Which actions should be targeted? *International Journal of Science Education*, Advance online publication. doi: 10.1080/09500693.2011.584079
- Boyes, E., Skamp, K. & Stanisstreet, M. (2009). Australian secondary students' views about global warming: beliefs about actions, and willingness to act. *Research in Science Education*, 39(5), 661-680.
- Cialdini, R.B., Reno, R., & Kallgren, C. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, 58(6), 1015-1026.
- Chokker, K., Dua, S., Taylor, N., Boyes, E. & Stanisstreet, M. (2011). Indian secondary students' views about global warming: beliefs about the usefulness of actions and willingness to act. *International Journal of Science and Mathematics Education*, 9, 1167-1188.
- CIA World Factbook, (2011). Oman. (<https://www.cia.gov/library/publications/the-world-factbook/geos/mu.html>; accessed July 2011)

- Corraliza, J.A., & Berenguer, J. (2000). Environmental values, beliefs, and actions: A situational approach. *Environment and Behavior*, 32(6), 832-848.
- Dietz, T., Stern, P.C. & Guagnano, G. (1998). Social structural and social psychological bases of environmental concern. *Environment and Behaviour*, 30(4), 450-471.
- El-Quosy, D. E-L. (2009). Fresh water. In M.K. Tolba, & N.W. Saab (Eds.), *Arab environment climate change: Impact of climate change on Arab countries 2009 report of the Arab form for environment and development*, (pp 75-86). (<http://www.afedonline.org/afedreport09/english/Char6.pdf>; accessed July 2010)
- Fishbein, M. & Ajzen, I. (1975). *Belief, attitude, intention and behaviour: an introduction to theory and research*. Reading: MA, Addison-Wesley.
- Freimuth, L., Bromberg, G., Mehyar, M. & Khateeb, N.A. (2007). *Climate change: a new threat to Middle East security*. Report prepared by EcoPeace/ Friends of the Earth Middle East for the United Nations Climate Change Conference, Indonesia, Bali. (http://www.foeme.org/index_images/dinamicas/publications/publ78_1.pdf; accessed July 2010).
- Hungerford, H.R. & Volk, T.L. (1990). Changing learning behaviour through environmental education. *Journal of Environmental Education* 21, 8-12.
- Husain, T. & Chaudhary, J.R. (2008). Human health risk assessment due to global warming – a case study of the Gulf Countries. *International Journal of Environmental Research and Public Health*, 5(4), 204-212.
- Kollmuss, A. & Agyeman, J. (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behaviour? *Environmental Education Research*, 8(3), 239-260.
- Mahmoud, A. (2009). Arab world lacks climate change data, says report. *News Report*, 9 December 2009 (<http://www.scidev.net/en/news/arab-world-lacks-climate-change-data-says-report.html>; accessed July 2010).
- Paice, E., Heard, S. & Moss, F. (2002). How important are role models in making good doctors? *British Medical Journal*, 325, 707-710.
- Rodriguez, M., Boyes, E. & Stanisstree, M. (2010). Spanish Secondary students' willingness to undertake specific actions to combat global warming: can environmental education help? *Psychology*, 1(1), 1-17.
- Said, A.M., Ahmadun, F., Paim, L.H. & Masud, J. (2003). Environmental concerns, knowledge and practices gap among Malaysian teachers. *International Journal of Sustainability in Higher Education*, 4, 305-313.
- Sivek, D.J. (2002). Environmental sensitivity among Wisconsin high school students. *Environmental Education Research*, 8(2), 155-170.
- Skamp, K., Boyes, E., & Stanisstree, M. (2007). *Global warming: Do students become more willing to be environmentally friendly as they get older?* Paper presented at the 38th Annual Conference of the Australian Association of Science Education, Freemantle, Australia.
- Stern, P.C. (1992). Psychological dimensions of global environmental change. *Annual Review of Psychology* 43, 269-302.
- US EPA (US Environment Protection Agency). (2010). *Climate change: What you can do?* Retrieved July 2010 from <http://epa.gov/climatechange/wycd/index.html>.
- Yencken, D. (2000). *Young people and the environment: The implications for environmentalism*. In D.Yencken, J.Fien, & H. Sykes (Eds.), *Environment, education and society in the Asia-Pacific: Local traditions and global discourses* (pp.212-250). London: Routledge
- Yencken, D., Fien, J. & Sykes, H. (2000). *Environment, education and society in the Asia-*

Pacific: Local traditions and global discourses. London: Routledge.

Authors

Abdullah Ambusaidi, Sultan Qaboos University, Sultanate of Oman. Email: ambusaid@squ.edu.om

Edward Boyes, University of Liverpool. E-mail: qe04@liverpool.ac.uk

Martin Stanisstree, University of Liverpool. E-mail: martstan@liverpool.ac.uk

Neil Taylor, University of New England, Australia. **Correspondence:** School of Education, University of New England, Armidale, NSW 2351, Australia. Email: ntaylor6@une.edu.au

Ummanlı fen öğretmen adaylarının küresel ısınma ile ilgili görüşleri: eylemler ve davranış göstermeye istekli oluş ile ilgili inançlar

44 maddeli anket hizmet öncesi öğretmenlerin çeşitli faydalı özel davranışların küresel ısınmayı azaltmaya nasıl yardım ettiği ve bu iki değişkenin hangi oranda ilişkili olduğuna ilişkin inançlarını belirlemek için kullanılmıştır. Veri toplama aracı, Umman sultanlığındaki, Sultan Qaboos Üniversitesindeki fen öğretmen adaylarına (n=104) uygulanmıştır. Sonuçlar, Ummanlı fen öğretmen adaylarının çoğunun küresel ısınmanın ve ilişkili iklim değişikliğinin şu anda gerçekleştiğini inandıklarını ve öğretmen adaylarının konu ile ilgili kaygılı olduklarını göstermiştir. Ayrıca, öğretmen adayları, insanların bu problemi düzeltmeye yardımcı olmak için alacakları tedbirlerin de farkındadırlar, ancak buna rağmen, bazı anahtar alanlara yönelik davranış göstermede isteksizdirler, örneğin, toplu taşıma araçlarının kullanımı ve yakıt tasarruflu küçük araç satın alma. Bu sonuç, öğretmen adaylarının küresel ısınmayı azaltmaya yardımcı olacak davranışlar ile ilgili anlayışa sahip ve bu konular ile ilgili kendi öğrencilerini bilgilendirmek için donanımlı görünmelerine rağmen, eğer kendi davranışları anlayışları ile paralellik göstermezse, rol model olarak kendi potansiyellerinin tehlikede olduğu anlamına gelmektedir.

Anahtar kelimeler: İnançlar, İklim değişikliği, çevre eğitimi, küresel ısınma, niyet, Umman, öğretmen adayı, fen eğitimi