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Environmental Education for Behaviour Change: Which actions should be targeted?

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ABSTRACT

One of the aims of environmental education is to persuade people to act in pro-environmental ways. This is particularly important with environmental problems that are believed to be both major and imminent, such as global warming; in such cases it is important that education be effective. There being no clear link between a person's overall environmental awareness and friendliness, this study aims to focus on specific environmental actions. Using quantitative methods to investigate students' beliefs about the usefulness of *specific* actions and their willingness to adopt them, it has been possible to construct a number of novel indices which indicate the potential effectiveness of education about those specific actions. The findings imply that altering a student's belief about some actions will likely have little effect on their willingness to undertake them. For some of these issues, this was because even those students with only a weak belief in the efficacy of the action were prepared to do it anyway. For others, such as supporting more use of nuclear power, it was because even those students who believed it would reduce global warming would not countenance nuclear energy. Education in these two areas may be ineffective because other incentives or disincentives dominate. For another set of issues, however, the practical benefits of education seemed more positive; increasing recycling, reducing the use of artificial fertilisers and planting more trees are examples of this.

INTRODUCTION

"The literature on public understanding of climate change indicates widespread awareness of the issue and a general concern, but limited behavioural response"

(Lorenzoni, Nicholson-Cole & Whitmarsh, 2007)

Twenty years ago the scientific evidence for an exacerbation of global warming[1] by a range of anthropogenic atmospheric pollutants was considered by some to be contentious (Stevenson, 1987; Boyes & Stanisstreet, 1993). Today, however, the weight of objective evidence persuades most people that the increase in global warming is a real phenomenon, caused by human-sourced greenhouse gases. Furthermore, authoritative sources agree that this is an increasing threat to the world's environmental integrity, its social well-being (IPCC, 1997; 2001, 2007), economic stability (Stern, 2007) and political security (Solana, 2008). In view of these persuasive predictions, it is increasingly important to design and apply effective measures for reducing greenhouse gas emissions. In part, this will depend on central government policies. The UK government, amongst others, set ambitious targets to reduce by 12.5% the levels of the major greenhouse gases by 2010 (relative to 1990 levels), with a reduction by 20% for carbon dioxide in particular. Furthermore, the political goal is to reduce carbon dioxide by 60% by 2050 (DTI, 2003). Unfortunately, since these targets were set it has become apparent that the 20% reduction in carbon dioxide will not be achieved, throwing doubt on the attainability of the 2050 target of a 60% reduction (DEFRA, 2006).

In a complementary manner, it is estimated that about half of UK energy use is by individuals, for domestic use and personal transport. In these sectors, however, energy consumption is in fact increasing (DEFRA, 2008). What is needed, then, are mechanisms to persuade individuals to reduce their carbon contribution by limiting their energy use. One of the aims of environmental education is to engender in learners a willingness to act in more environmentally sustainable ways

[1] In this paper, for economy of words, we use the term 'global warming' to refer to the exacerbation of the natural greenhouse effect by the addition of anthropogenic pollutants to the atmosphere.

(Mentzer & McEwen, 1999; Jurin & Fortner, 2002; Heimlich & Ardoin, 2008) and, in the context of global warming, this practical role of eliciting behaviour modification, has assumed new importance and urgency.

Early models of behaviour change in an environmental context became known as 'information deficit models' (Burgess, Harrison & Filius, 1998). These were presaged on the assumption that if people understood more about the environment and the actions that would cause, or avoid, environmental degradation, they would behave in a rational manner and adopt environmentally sympathetic behaviour patterns. In other words, it was believed that there was a relatively direct and positive relationship between a person's cognitive base about environmental problems and their willingness to act in such a way as to reduce these problems. Some studies have shown that knowledge and behaviour are indeed related (Yencken, 2000). In many other cases, however, it seems that the relationship between knowledge and action is not robust (Rajecki, 1982; Hungerford & Volk, 1990; Posch, 1993; Kollmus & Agyeman, 2002); there is what has come to be known as a 'gap' between cognition and action (Kollmus & Agyeman, 2002).

In part, this 'gap' is due to the fact that behaviour is influenced by a plethora of other factors, not just knowledge. Other beliefs, social pressures, physical facilitators and inhibitors can synergistically influence whether or not a particular action is pursued (Corraliza & Berenguer, 2000). Similarly, descriptive and injunctive social norms influence whether or not a person acts in an environmentally sympathetic fashion (Cialdini, Reno & Kallgren, 1990). Perhaps most relevant to the present study is the finding that situational influences such as a person's belief in their own self-efficacy also partly determines the extent to which he or she acts in a pro-environmental manner (Devine-Wright, Devine-Wright & Flemming, 2004; Laskova, 2007). A further issue that has emerged as workers have attempted to generate models of the incentives and disincentives to pro-environmental behaviour is that there are limitations in studying links between *general*

environmental attitudes and potential behaviour patterns (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Dietz, Stern & Guagnano, 1998; Stern, 1992).

Given this complexity, and the pressing need for a reduction in the emission of anthropogenic greenhouse gases, we have attempted to explore the role that education about the usefulness of *more specific* pro-environmental actions might play in eliciting changes in behaviour. We have designed an instrument that questions respondents about their willingness to countenance *specific* pro-environmental behaviours and, separately, their beliefs about the possible benefits of these *particular* behaviours on one environmental problem - global warming. Three research questions have been addressed. Firstly, the degrees to which students report being willing to undertake a variety of specific 'environmentally friendly' actions have been ascertained. Secondly, the extents to which students believe these particular actions would be effective in reducing global warming have been investigated. Thirdly, the relationship between these two things, students' reported willingness to undertake specific actions and their beliefs about the usefulness of the same actions, has been explored. The overall aim was to determine how effective increasing understanding about particular actions through specific environmental education of a practical nature might be in persuading individuals to increase their willingness to undertake those actions, so that environmental education might be targeted to those areas in which it is likely to be most effective.

METHODS

This study employed a novel questionnaire to probe the views of secondary students. The study was initiated in the UK, but has since extended to Australia, the USA and a number of countries in mainland Europe; here we report the findings of the UK study.

Design of the questionnaire

The questionnaire consisted of a coversheet, two main sections and a short final section. The wording of the questionnaire items from the two main sections is shown in Figure 1, where the ordering is different to that in the questionnaire for the reasons given below. The coversheet asked respondents to record their Year Group and gender, and the fourth section, at the end of the questionnaire, contained 4 items designed to probe the level of students' concern about global warming, the extent of their perceived knowledge about global warming, the degree to which they considered themselves to be environmentally 'friendly', and whether or not they believed that global warming was a real phenomenon that was already happening. These questions, and the available responses, are shown in Figure 2.

The first of the two main sections of the questionnaire contained 20 items, 16 of which were about actions that would contribute to the amelioration of global warming; these actions were chosen to be representative and generally accepted as important. Most of the ideas in these items 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 items concerned indirect actions, such as ways of supporting increased environmental taxation or legislation. The four remaining items were more idiosyncratic in nature; these focused on ideas that had been raised by students themselves in earlier research (Boyes & Stanisstreet, 1993). These four distracters were added to the 16 so that respondents would not feel obligated to respond positively to all questions; the results from the four items will not be considered in this paper.

The focus of the first main section of the questionnaire was the degree to which students would be willing to undertake a particular action "for the sake of the environment and the future of the Earth"; no mention was made of global warming at this stage. Thus, the items took the form of a conditional clause indicating the personal cost or inconvenience of the action, followed by a simplified description of the action. The wording of the items can be seen in the right hand column

of Figure 1, and the available responses to these items, which ranged from "I would definitely do it" to "I would probably not do it", and the ways in which they were scored, are shown in the right side of Figure 3. The scored responses produced by the items in this section of the questionnaire were designated students' *Degree of Willingness to Act*.

The 20 items in the second main section of the questionnaire concerned the same pro-environmental actions as those in the first main section, although the order was different so that the pairing of the questions was not immediately apparent to the respondents. Here, however, the focus of the questioning was on the extent to which respondents believed that the actions were useful in alleviating global warming. The wording of these items can be seen in the left column of Figure 1, and the available responses, which ranged from "quite a lot" to "nothing at all really", and the ways in which they were scored, are shown in the left side of Figure 3. The scored responses were designated students' *Believed Usefulness of Action*.

Figure 1 also illustrates the pairing of the items and the themes within the questionnaire. Not only were the items paired, however, the available responses in the two main sections of the questionnaire were designed to 'match', in semantic terms. Figure 3 illustrates this, where the two response scales are shown in apposition. If, for example, a student believed that a particular action would help by 'quite a lot', this was matched in the other section to the response that they would 'definitely' be willing to do it; each of these responses received a score of 1. Conversely, if a student believed that an action would reduce global warming 'by nothing at all', this is matched to the action section response that they would 'probably not' do it, and both responses received a score of zero. The intermediate responses were also designed to correspond in a similar way, by semantics and score.

The final wording of the paired questionnaire items and matched response scales came about from a series of discussions with a group of researchers and teachers. The questionnaire was trialled with 134 students (age 14 years), and the only modification entailed the removal of the word 'insulation' and the rephrasing of the pair of questions concerned.

Construction of the indices

From the responses to the two sections of the questionnaire, the *Degree of Willingness to Act* and *Believed Usefulness of Action*, a number of derived indices were produced which have been used to explore the connections between them. Although the two response scales are ordinal and although they measure different things, it was felt that because of their semantic matching (Figure 3), some mathematical manipulation of the data is acceptable; this will be explored below.

Potential Effectiveness of Education

The indices we wish to focus on here relate to the extent to which increasing the understanding about the efficacy of a particular action through specific environmental education might persuade individuals within a cohort to be willing to undertake that action. To obtain these for a particular action, student measures of the *Degree of Willingness to Act* were plotted against their value of the *Believed Usefulness of Action*, and the trend line was fitted. This produced a graph of the type exemplified in Figure 4. The semantic matching of the responses means that linear regression is less sensitive to the errors involved in using ordinal scales. The slope of such a graph represents the extent to which, in general, the willingness of students to undertake an action might be said to be dependent upon their belief in the usefulness of that action. The gradient, therefore, provides a measure of the extent to which willingness to undertake an action might be increased by persuading students of the environmental effectiveness of that action; we have called this gradient the *Potential Effectiveness of Education*. Once the line has been determined for a pair of questions, two other derived indices can be calculated from the intercepts. The intercept when the *Believed Usefulness*

of Action is zero represents the likely action of those students who believed that such an action would be ineffective in reducing global warming; we term this the *Natural Willingness to Act,* and Figure 4 is annotated to show this. In a complimentary fashion, the distance marked *Natural Reluctance to Act* in Figure 4 is a measure of the extent to which students will not take action, even though the *Believed Usefulness of Action* is at its maximum. These three indices may be useful in comparing the potential effect of education about different specific pro-environmental actions.

Comparing the values of the *Potential Effectiveness of Education* for different actions gives an indication of those actions for which education about their potential effectiveness might lead to behaviour change, and other actions where education will probably be less effective. On a population basis, however, there is another measurement that will influence the efficacy of education to this end, namely the proportion of the population who are not already reporting an intention to take action. Thus, education would be most productive in terms of behaviour change if directed at those actions which relatively few of the population are already willing to undertake. A final index was therefore calculated, the *Potential Usefulness of Education*, by multiplying the *Potential Effectiveness of Education* by the proportion of students in who would 'probably not' or only 'perhaps' undertake the action.

RESULTS

In all, 961 students in Year Groups 7 through 11 from four state Community Comprehensive schools in the North West of England completed the questionnaire. Of this sample, 18% were in Year 7, 23% were in Year 8, 25% were in Year 9, 17% were in Year 10, and 17% were in Year 11. Males comprised 52% of the cohort, females 48; males and females were evenly distributed over the years. The responses to the final four questions provided some background information about the beliefs and views of the students. Some 61% of the students thought or were sure that global warming was happening, with half of this figure (31%) being sure of this. About half of the

students expressed concern about global warming, with 16% reporting being 'very worried' and a further 33% reporting being 'quite worried'. Few students, about 14%, thought that they were well informed (knew 'a lot') about global warming, although a further 39% considered they knew 'something' about it. Nearly half of the cohort (45%) thought of themselves as being either 'very' or at least 'quite' environmentally friendly. Thus, many of this group of students believed that global warming is a real phenomenon, few thought that they were especially well informed about it, and about half were concerned about its consequences.

Students' *Degree of Willingness to Act*

The findings concerning students' *Degree of Willingness to Act* for different pro-environmental actions are given in the first column of Figure 5 and illustrated graphically in Figure 6. In Figure 6, the items are arranged in descending order according to the combined percentages of students who would 'definitely' or 'almost certainly' undertake the action; in the descriptions below, these same percentages are reported. The direct action to which most students were amenable (68%) was to switch off un-used electrical appliances. The prospect of installing home insulation was acceptable to about half of the students (49%), as were the ideas of recycling materials (48%) and paying more for energy-efficient domestic appliances (44%). Over a third of the cohort (39%) were willing to pay for more tree-planting, although fewer (28%) would accept the increased price premium for food grown without artificial fertilisers, and even fewer (21%) would be prepared to reduce their consumption of meat. In terms of personal transport, only about a fifth of the students (20%) would consider getting a smaller car and a similar proportion (19%) would accept reducing car use by using public rather than private transport. Rather few of the students (15%) would accept buying fewer fashion items. In terms of energy production, few students (10%) felt that using nuclear power was acceptable and, perhaps surprisingly, relatively few (23%) would consider paying more for renewable energy sources. Most of the indirect actions were also unpopular. Only about a quarter of the students would be prepared to undertake more education about environmental issues

(23%) or allow their vote to be influenced by support for new environmental legislation (21%), international agreements (21%) and, for even fewer, increased environmental taxation (16%). Thus, students were willing to undertake different environmental behaviours to varying extents. There was a strong association between most of the 16 *Degree of Willingness to Act* items and the question in the third section of the questionnaire about the extent to which students were worried about global warming. This will be discussed later.

Students' *Believed Usefulness of Action*

Items in the second main section of the questionnaire explored students' beliefs about the usefulness of the various actions in reducing global warming, their *Believed Usefulness of Action*, and the data from the responses are given in the second column of Figure 5 and illustrated graphically in Figure 7. In Figure 7, the items are arranged in descending order according to the combined percentages of students who thought that the action would reduce global warming by 'quite a lot' or by 'a fair amount'. In the descriptions which follow, these same percentages are reported. Students apparently made a link between global warming and personal transport; two actions thought by many of the students to contribute to a reduction in global warming were to reduce car use (68%) and drive smaller cars (50%). Energy production also seemed to be linked with global warming in students' minds, since many believed that production of energy from renewable sources (64%) and from nuclear sources (47%) could play a role in reducing global warming. Perhaps linked to this, another relatively popular idea was energy conservation by switching off unused electrical items (51%). Surprisingly, rather fewer students realised that installing home insulation (39%) or the use of energy-efficient domestic appliances (37%) could reduce global warming. Tree planting was also thought to contribute to decreasing global warming by more than half of the students (54%), and almost as many (47%) appreciated the role that increased recycling could play. Rather fewer of the students (35%) realised that reducing the use of artificial fertilisers and decreasing meat consumption (16%) could lessen global warming, perhaps

because the mechanisms involved gases other than carbon dioxide, the latter being perhaps the most well-known greenhouse gas. Just over a quarter of the students (28%) appreciated that buying fewer new items could help to reduce global warming. Of what we have termed the 'indirect actions', those related to international agreements were thought to be the most effective (59%), with education (49%), legislation (43%) and taxation (37%) being thought less so. Thus, students believed that the various environmentally-friendly actions which had been suggested in the questionnaire would be differentially effective in reducing global warming.

Relationship between the *Degree of Willingness to Act* and *Believed Usefulness of Action*

As explained above, a number of indices can be obtained from the responses to the two main sections of the questionnaire, where the scored items were called the *Degree of Willingness to Act* and the *Believed Usefulness of Action*. Some of these will now be discussed.

The *Potential Effectiveness of Education* provides an indication of the extent to which increasing understanding about particular actions through specific environmental education might persuade individuals to be willing to undertake those actions. This relationship was quantified by linear regression, and the results are illustrated schematically in Figure 4; the values of the indices from the regression are summarised in the last four columns of Figure 5. The first of these, the slope of the regression line constructed when the *Degree of Willingness to Act* and the *Believed Usefulness of Action* for pairs of actions are plotted, has been designated the *Potential Effectiveness of Education*; a high value of this index represents a steep relationship between the extent to which students believe an action to be effective and their willingness to undertake that action. In such cases, persuading students of the efficacy of the action should result in more students purporting to take that action. Where the relationship is shallower, indicated by a lower value of the *Potential Effectiveness of Education*, education about the action is less likely to result in more students from this cohort adopting it. The other two indices, the two vertical dimensions marked in Figure 4,

provide indicators of the extent to which students will undertake the action anyway, without believing in its effectiveness (*Natural Willingness to Act*), and of the extent to which students will avoid the action even if they believe it is highly effective (*Natural Reluctance to Act*).

Figure 5 shows that for some actions the value of the slope of the line, the *Potential Effectiveness of Education*, was low, suggesting that there was little change in the willingness to undertake an action for different beliefs in the effectiveness of that action. For example, this was true for the action of switching off unused electrical items (0.14). In this case, the slope of the line was shallow because the *Natural Willingness to Act* was relatively high (0.63); students were prepared to take this action in any case. In this case it is likely that other motivators, such as reducing electricity bills, coupled with a relatively low level of inconvenience, meant that students would be taking this action anyway. The value of the *Potential Effectiveness of Education* was also fairly low for some other actions such as adopting more nuclear power (0.15), reducing car use (0.18), avoiding buying new fashion items (0.15) or purchasing smaller cars (0.17). In these cases, however, the slope of the line was shallow because the *Natural Reluctance to Act* tended to be quite high; even if students believed these actions to be effective in reducing global warming, they seemed unwilling to undertake them. In these cases it is probable that other disincentives, such as major inconvenience, substantial changes in lifestyle or concerns over nuclear energy, would prevent students taking these actions even though they believed that the actions could make a substantial contribution to the reduction of global warming. In yet other cases there was a steeper association between a belief in the effectiveness of an action and a willingness to undertake it. Increasing the amount of material that is recycled (0.34), reducing the use of artificial fertilisers (0.27) and tree planting fell into this category (0.26). In these cases, the *Natural Willingness to Act* and the *Natural Reluctance to Act* were both relatively low, and so the slope of the line was fairly steep. For these specific actions, then, education which persuades students of the effectiveness of the action might well result in more of the students adopting the action. In summary, there are some pro-environmental actions

that will probably not be induced by convincing students of their efficacy, and there are other, different, environmentally sympathetic actions which may well be encouraged by persuading students of their effectiveness.

There is one other factor that will impinge upon the degree to which environmental education might be effective on a population level. The overall effectiveness of such education will be maximised when directed at those actions which a high proportion of the population are not already undertaking. In an attempt to give some quantitative comparison to the various actions raised in the questionnaire, a final index, the *Potential Usefulness of Education,* was constructed by multiplying the *Potential Effectiveness of Education* by the proportion of students who would 'probably not' or only 'perhaps' undertake the action; these data are shown in the final column of Figure 5. This multiplication produces much smaller numbers, but the bigger of these indicate that teaching about the effects of reducing meat consumption (0.14), lowering the use of artificial fertilisers (0.12), decreasing car use (0.11) and increasing the proportion of energy generated from renewable sources (0.11) should be useful areas on which to concentrate teaching.

Differences between subsets of students

Differences between various groupings of students were explored in a number of ways. ANCOVA was used for the basic scores on the 32 items when looking at gender and year group together. For the derived indices, gradient and intercept were compared for any two groups using the standard technique of dummy variable creation and fitting a multiple linear regression model against the independent variable, the comparison variable (dichotomous) and the derived variable. Differences from any of these tests are noted below only if they are at the 0.05 level or better. When discussing these differences, percentages will be used for the main questions (defined as in the first two columns of Figure 5), whilst the derived indices will simply have their values compared (explained in the later columns of Figure 5).

Differences between male and female students

For three of the issues, more females than males were prepared to take action; theses involved switching off unused electrical items (65%, 71%), reducing car use (15%, 23%) and eating less meat (15%, 27%). In terms of belief or understanding, a further three issues showed that females once again had a greater sensitivity to: using energy-efficient domestic white goods (33%, 40%), reducing the purchase of new fashion items (26%, 31%), taking into account a politician's willingness to legislate on the environment when voting (38%, 48%). Measures of the *Potential Effectiveness of Education*, showed only one difference between the sexes and that was for the question relating to international agreements (0.15, 0.33), where it appears that females seem likely to be more influenced by education. On two issues there was a difference in the *Natural Willingness to Act*; for eating less meat females showed a greater natural willingness (0.22, 0.31), in line with the overall measurement for the question, but they seemed less naturally willing to vote in accordance with politicians views on international agreements (0.29, 0.15).

Differences between students in different year groups

In the descriptions below, the figures given are those for students in Year 7, 8, 9, 10 and 11. Differences between students in different year groups are reported below only if ANCOVA revealed statistically significant differences giving a trend across the year groups. By these criteria there were no significant and consistent trends across the year groups for students *Degree of Willingness to Act*. There were a number of differences, however, for students' *Believed Usefulness of Action*. For the most part, the level of students' *Believed Usefulness of Action* decreased over the year groups. So, fewer of the older students believed that adopting the use of smaller cars (57%, 55%, 52%, 51%, 33%), insulating homes (44%, 45%, 42%, 39%, 21%), switching off un-used electrical items (61%, 57%, 48%, 48%, 39%), recycling more (54%, 60%, 47%, 37%, 33%), reducing the use of artificial fertilisers (35%, 46%, 37%, 29%, 22%), buying fewer fashion items

(35%, 33%, 27%, 25%, 21%), reducing car use (76%, 70%, 65%, 71%, 58%), eating less meat (19%, 21%, 16%, 8%, 10%), using energy-efficient domestic appliances (47%, 42%, 31, 39%, 25%) would reduce global warming either by 'quite a lot' or by 'a fair amount'. Confidence in the effectiveness of the indirect actions also declined over the year groups. Thus, fewer of the older students thought that voting in accordance with promises on environmental legislation (53%, 46%, 38%, 45%, 36%) and taxation (47%, 38%, 34%, 38%, 27%), and international agreements (72%, 60%, 55%, 60%, 51%) could help to reduce global warming.

There were statistically significant increases in the *Potential Effectiveness of Education* across the year groups for the actions of planting trees (0.19, 0.16, 0.21, 0.28, 0.50) and increasing adoption of renewable energy (0.16, 0.23, 0.09, 0.24, 0.38), suggesting perhaps that persuading older school students of the effectiveness of these actions might be more effective than teaching younger students. This trend was also evident in two of the indirect actions, related to supporting international agreements (0.16, 0.20, 0.11, 0.19, 0.43) and being prepared to undertake more environmental education (0.19, 0.10, 0.18, 0.25, 0.36). However, it was also noticed that for these, and only these issues, the *Natural Willingness to Act* started high and decreased across the year groups, as the *Potential Effectiveness of Education* increased. The conclusion would seem to be that young students are less discriminatory and have a high willingness to act regardless of their understanding of the issue. Older students are more able to process the information which they have, or which they believe, and with these issues show a response in their intended actions which is more in line with their understanding. This perhaps suggests that the teaching of these issues might be best targeted at older students.

Differences between more and less concerned students

Finally, the relationship between the extent of students' concern and their willingness to act in various pro-environmental manners was investigated. Students were grouped according to their

responses to a question in the final section of the questionnaire about how worried they are about global warming. Those who indicated that they were 'very' or 'quite' worried were considered to be 'more concerned' (n=452); those who responded that they were 'a little bit worried' or 'not worried at all' were considered to be 'less concerned' (n=460).

When the derived indices were compared for these two groups of students, it became apparent that the values for the *Natural Willingness to Act* indices were consistently higher for the more concerned students than for the less concerned students for all actions other than the increased adoption of nuclear power. In contrast, only two of the values of *Potential Effectiveness of Education* showed statistically significant differences between the two groups, and these differences were relatively small. The details can be seen in Figure 8. It seems clear that, regardless of the degree of worry about global warming, the sense in which action might be influenced by understanding or belief is fairly stable, though different for each issue. On the other hand, the *Natural Willingness to Act*, the likely action even when it is believed to be ineffective, is significantly greater for almost all issues for those who are more concerned about global warming. Interestingly, the biggest differences are for the use of smaller cars (0.40, 0.25) and for the use of public transport instead of cars (0.37, 0.15). These issues seem to be little affected by education (the *Potential Effectiveness of Education* is small whether students are worried or not, varying between 0.07 and 0.12) and, as noted above, these are demanding behaviour changes that affect people's personal freedom and status. Worry about global warming, on the other hand, does seem to have some impact on action in this area. It has been suggested by research on air pollution (Boyes, Stanisstreet, Myers, Skamp & Yeung, 2007) that fear or worry, especially for western students, has a considerable influence on their stated willingness to take certain actions. In this case it would seem to be regardless of what students believe about the effectiveness of that action. Thus it would appear that the worry about global warming and its consequences might precipitate action, even if that action is thought unlikely to be helpful: a kind of insurance policy.

The one exception from Figure 8 is for the idea of being willing to pay more for electricity if it were produced by nuclear power. The *Natural Willingness to Act* in this way is small (around 0.2) and the same for both groups of students. Clearly there are other concerns which, in the case of nuclear power, take precedent.

DISCUSSION

Approximately two thirds of the students in this study appreciated that global warming is a real phenomenon, paralleling the high general awareness of global warming in the adult population (DEFRA, 2008). Furthermore, about half of the respondents expressed concern about the consequences of global warming, again similar to the adult population (DEFRA, 2008), suggesting that consciousness of, and apprehension about, global warming are beginning to develop early through education and publicity. Perhaps because of this concern and anxiety, UK adults in general appear to support, in principle at least, both individual and political action to reduce global warming (BBC, 2007); about half of the UK population believe that modifying individuals' behaviour would diminish global warming. In a complementary manner, a proportion of the population in general would support the introduction of further environmental legislation, partly because this is seen as fairer, but also because it means that pro-environmental behaviour does not rely only on an individuals' willingness to act (Darier & Schule, 1999).

In the context of these general attitudes, the findings of the present study indicate that among UK secondary students there is a differential willingness to undertake various pro-environmental actions - what we have termed the *Degree of Willingness to Act*. For the more direct actions, what might be considered individual actions, for example, many students report a willingness to switch off unused electrical items in the home, whereas far fewer are prepared to alter their habits concerning personal transport by using public rather than private transport, or by countenancing the use of smaller, more

energy-efficient private vehicles, unless they are particularly worried about global warming. The differential willingness to undertake diverse pro-environmental actions is similar to that reported for adults, who are more prepared to increase recycling or to take action to conserve energy in domestic situations, but less willing to modify their travel habits (Shackley *et al*, 2004; Kasemir *et al*, 2003; O'Connor *et al*, 1999). Each of the pro-environmental actions raised in this study has associated incentives and disincentives for young people, the nature and extent of which will differ between different actions. Switching off un-used electrical items, for example, causes only minor inconvenience and may carry an additional incentive in that it aligns with parental exhortations to 'save electricity' for financial reasons. Use of public transport, on the other hand, may be perceived as carrying a major inconvenience and could be associated with a negative social image amongst school students' peer groups, with social norms acting as a disincentive (Cialdini, Reno & Kallgren, 1990). Thus, when considered in isolation, the likelihood of undertaking any particular pro-environmental action is a balance of a general feeling of benefiting the environment, coupled with more concrete personal incentives, disincentives and concern. For indirect actions such as the influencing of voting patterns, rather few of the students were willing to consider increased environmental taxation, legislation or education or, perhaps surprisingly, even international agreements. Whilst it is unclear what voting priorities young people may have, a part of their unwillingness to consider such issues may be because any outcomes would be brought about by *politicians*, and because they have a general distrust of politicians (Smith, Stanisstreet & Boyes, 2005). Such mistrust has major implications for a population that approves in principle of the imposition of pro-environmental actions by central government, but seems less willing to take this into account when voting. This may be through lack of faith in its politicians to put such actions into place, because of a perceived lack of competence or integrity.

The findings of the present study also indicate that students consider that different actions may have different levels of usefulness in reducing global warming, a measurement we termed the *Believed*

Usefulness of Action. For example, reducing car use, generating electricity from renewable sources and switching off un-used electrical items were thought to contribute to reducing global warming. In addition, tree planting was seen as useful in this context. The prime effect of all of these behaviours relate to atmospheric carbon dioxide, either by decreasing carbon dioxide emissions or, in the case of tree planting, by increasing the rate of removal of carbon dioxide from the atmosphere. Reducing the use of artificial fertilisers or decreasing the use of meat production was thought to be less effective. In these cases the greenhouse gases involved are nitrogen oxides and methane, respectively. It may be that the efficacy of such pro-environmental behaviours in terms of global warming may be less well appreciated because the effect of these two gases is less well known than that of carbon dioxide (Boyes & Stanisstreet, 1993, 2001), the role of which has been more recently re-enforced by phrases such as 'carbon footprint', 'carbon dependency' and 'carbon trading'. Students were also not strongly aware of the link between consumption of new 'fashion' items and global warming, perhaps because the energy consumed in their manufacture and transport to the point of purchase does not come immediately to the minds of young people.

By combining the data obtained from the two main sections of the questionnaire, the *Degree of Willingness to Act* and the *Believed Usefulness of Action*, it was possible to derive a series of indices to gain insight into the probable advantage, in terms of changing behaviour, of persuading young adults of the efficacy of different pro-environmental behaviours in ameliorating global warming. In particular, the *Potential Effectiveness of Education* is a measure of the association between belief in the effectiveness of an action and the willingness to undertake it. Certain actions had a rather low *Potential Effectiveness of Education*, indicating that education might be less effective for such actions. In some cases, such as switching off un-used electrical items, this was because students showed a high *Natural Willingness to Act* - they would perform such actions irrespective of a belief or not in their merit. Education about the way in which such actions might reduce global warming might be of only marginal benefit, to this age group, in terms of behaviour

change. In other cases a low *Potential Effectiveness of Education* was associated with a high *Natural Reluctance to Act.* Here, even a belief in the efficacy of an action did not promote its uptake, presumably because there were other disincentives in place; the nature of such disincentives would, of course, vary between different actions. For example, adoption of nuclear power may show a high *Natural Reluctance to Act* because of fears about environmental or health impacts of nuclear power. Change in transport habits, such as the use of smaller cars or substitution of public for private transport, could be somewhat impervious to education because environmental sensitivity would be out-weighed in decision-making by preferences about lifestyle or personal convenience, an example of a physical inhibitor acting as a disincentive (Corraliza & Berenguiar, 2000). In addition, students were resistant to reducing their purchase of new 'fashion' items, perhaps because consumption of this sort is perceived as a natural characteristic of a their western life-style. In such cases, as above, education alone might be of only limited benefit, although it might be a useful component in a series of measures. For example, introduction of potentially unpopular environmental legislation might be made more acceptable if there is a general understanding of why it is necessary.

In the case of other types of pro-environmental action, there was a stronger relationship between the extent to which an action was believed to be effective in reducing global warming and a willingness to undertake it. Increasing recycling, reduction in the use of synthetic fertiliser, tree planting and the benefits of home insulation and energy-efficient domestic appliances were examples of these actions. The first of these might be especially relevant because this action is within the locus of control of individual young people; indeed, in some cases young people may influence the practices of the whole family in which they live.

With virtually all of the issues, the relationship between belief about an action and stated intention to act did not depend on how worried the students were about global warming. On the other hand,

the extent to which the more worried students were prepared to take action even when they did not believe it to be effective, was considerably greater; that is, the *Natural Willingness to Act* was greater in the more concerned individuals. Perhaps the more concerned students make the risk assessment that, even though the action might have little or no effect, it is worth taking *just in case,* because they worry about the outcome being so devastating. The one issue that did not follow this pattern was the idea of being willing to pay more for electricity if it were produced by nuclear power. The risk assessment for global warming seems to pale into insignificance compared to the risk assessment made for the proliferation of nuclear energy in the minds of even those students who are concerned about global warming.

When the size of the potential education audience, the proportion of those who do not already intend to undertake such actions, is compounded into an index, the *Potential Usefulness of Education*, certain specific actions emerge as useful targets for education. Thus, a reduction in meat consumption (and therefore production) and a willingness to pay more for vegetables and cereals grown without the use of artificial fertilisers, together with a decrease in car use and production of energy from renewable sources are all actions that have a potential audience, and for which intended behaviour seems to be strongly influenced by a belief in their effectiveness. As above, the first two of these are under at least partial control of the individual concerned.

This study reveals that for different actions there is a different degree of association between a belief in the efficacy of an action and a willingness to undertake it; this is one reason why environmental education in *general* terms might be less than fully effective. Even in the case of specific actions, it is apparent that for some actions education to persuade learners of their usefulness in terms of a major environmental problem has little potential on its own to be effective in terms of behaviour modification.

The present findings suggest that where there were differences between the responses of male and female students, females tended to be more sensitive to the benefits of certain pro-environmental actions, and more willing to undertake other pro-environmental actions. This is congruent with the observation that females tend to score more highly than males on instruments that measure of environmental attitudes (Burger *et al*, 1998; Taskin, 2009). The results also indicate that the degree of association between belief in the effectiveness of an action and a willingness to undertake it differs across different age groups of students. It appears, in contrast to our intuition, that older secondary students might respond more to teaching than their younger counterparts. Perhaps a potential hazard, then, of initiating education about pro-environmental actions too early might be that of over-exposure; the possibility is that by the time that students reach their most receptive stage they may be in a state of environmental 'fatigue', in the same way that donors to charity are thought, eventually, to suffer 'compassion fatigue'. In addition to this heterogeneity that could be linked to overt independent factors such as gender and year group, it appears that there is an association between the level of concern among students about global warming, and their willingness to undertake pro-environmental actions. Education strategists and practitioners should be aware, therefore, of this further heterogeneity within the student population; like adults (Lorenzini, Nicholson-Cole & Whitmarsh, 2007) students will not be uniform in their behavioural responsiveness to environmental education even about specific actions.

This research has sought not only to elicit opinions of students about their understanding (belief) and purported actions, but also to find some indicators of the likely usefulness of education in bringing about a change of behaviour. Space has not allowed us to discuss here the straightforward discrepancy between the two measures of belief and action, but from manipulation of them, and the indices produced, it has been possible to see the effect of different inhibitors and facilitators to action for each of the issues investigated. It would be interesting, in further research, to investigate the detail of those things which restrain or encourage action, remembering that a wide variety of

factors are likely to be involved, and that these will differ extensively for each action under consideration.

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Figure 1 Wording of the questionnaire items. The main items of the questionnaire displayed so that the 'pairing' of the items can be seen.

Themes	Items about the *Believed Usefulness of Action*	Items about the *Degree of Willingness to Act*
Direct actions		
Transport (use)	If people didn't use their cars so much, 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
Transport (type)	If people had smaller cars that used less petrol or diesel, global warming would be reduced	Even if it was not as fast or luxurious, I would try to get a car that uses less petrol or diesel
Power generation (renewable)	If more of our energy was produced from the wind, waves and sun, 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
Power generation (nuclear)	If more of our energy was produced from nuclear power stations, 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
The home (electricity use)	If people used less electricity in their homes, global warming would be reduced	To save electricity, I would switch things off at home when I didn't need them
The home (insulation)	If people got their homes insulated better, global warming would be reduced	Even though it cost me money, I would get extra insulation for my home
The home (consumer durables)	If people got things for their homes (like fridges and washing machines) that used less energy, 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
The home (consumables)	If people were prepared to buy fewer new things and make do with the old ones, 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
Environmentally-friendly (trees)	If more trees were planted in the world, global warming would be reduced	Even if I had to pay more taxes, I think there should be more trees planted in the world
Environmentally-friendly (recycle)	If people recycled things more, global warming would be reduced	Even if it was more trouble for me, I would recycle things rather than just throw them away
Food (Reducing meat)	If people eat less meat, global warming would be reduced	Even if I really liked meat, I would eat fewer meals with meat in them
Food (Reducing artificial fertilizers)	If farmers stopped using artificial fertilisers with nitrogen in them, global warming would be reduced	Even if it was more expensive, I would buy food grown without the use of artificial fertilisers
Indirect actions		
Environmental legislation	If politicians made the right kind of new laws, global warming would be reduced	I would vote for a politician who said they would bring in laws to reduce global warming, even though it would stop me doing some of the things I enjoy
Environmental taxation	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 increase taxes to pay for reducing global warming, even though it meant me having less money to spend
Environmental education	If people were taught more about it, global warming would be reduced	I would like to learn more about global warming, even though it would mean extra work for me
Environmental International cooperation	If there could be more agreement between different countries about not putting certain gases into the air, global warming would be reduced	Even though it might mean some inconvenience to me (like changing my job), I would vote for a politician who said they would sign agreements with other countries on global warming

The items of the questionnaire are displayed so that the 'pairing' of the items can be seen. In the actual questionnaire, the items were in random order, and paired items were in different orders in the two main sections.

Figure 2 Wording and available responses for the final four items of questionnaire

Items	Available responses
How worried are you about what Global Warming might do to the environment?	I am very worried I am quite worried I am a little bit worried I am not worried at all
How much do you think you know about Global Warming?	I know a lot about global warming I know something about global warming I know a little about global warming I know almost nothing about global warming
How 'environmentally friendly' do you think you are? (How much do you think you 'take care of' the environment by the things you do?)	I am very environmentally friendly I am quite environmentally friendly I am a bit environmentally friendly I am not at all environmentally friendly
Do you think that Global Warming is really happening now?	I am sure global warming is happening I think global warming is happening I don't know whether global warming is happening or not I am think global warming is not happening I am sure global warming is not happening

Figure 3 Wording of the permissible responses to the two sets of items.

Believed Usefulness of Action If I thought an action would help global warming by…	Score	*Degree of Willingness to Act* Then I would…	Score
by quite a lot	1.00	definitely do it	1.00
by a fair amount	0.75	almost certainly do it	0.75
by a small but useful amount	0.50	probably do it	0.50
by a very small amount - hardly noticeable	0.25	perhaps do it	0.25
by nothing at all really	0.00	probably not do it	0.00

The wording of the permissible responses is displayed 'matched'. This 'matching' suggests the minimum action ('then I would') that might reasonably be expected for a given belief about the usefulness of that action. The figures show the scores assigned to the different responses; these enabled various coefficients to be constructed.

Figure 4 Annotated graph to show relationship between the *Degree of Willingness to Act* and the *Believed Usefulness of Action*

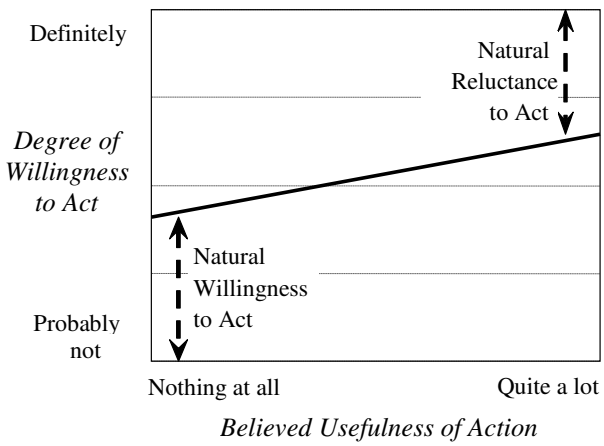
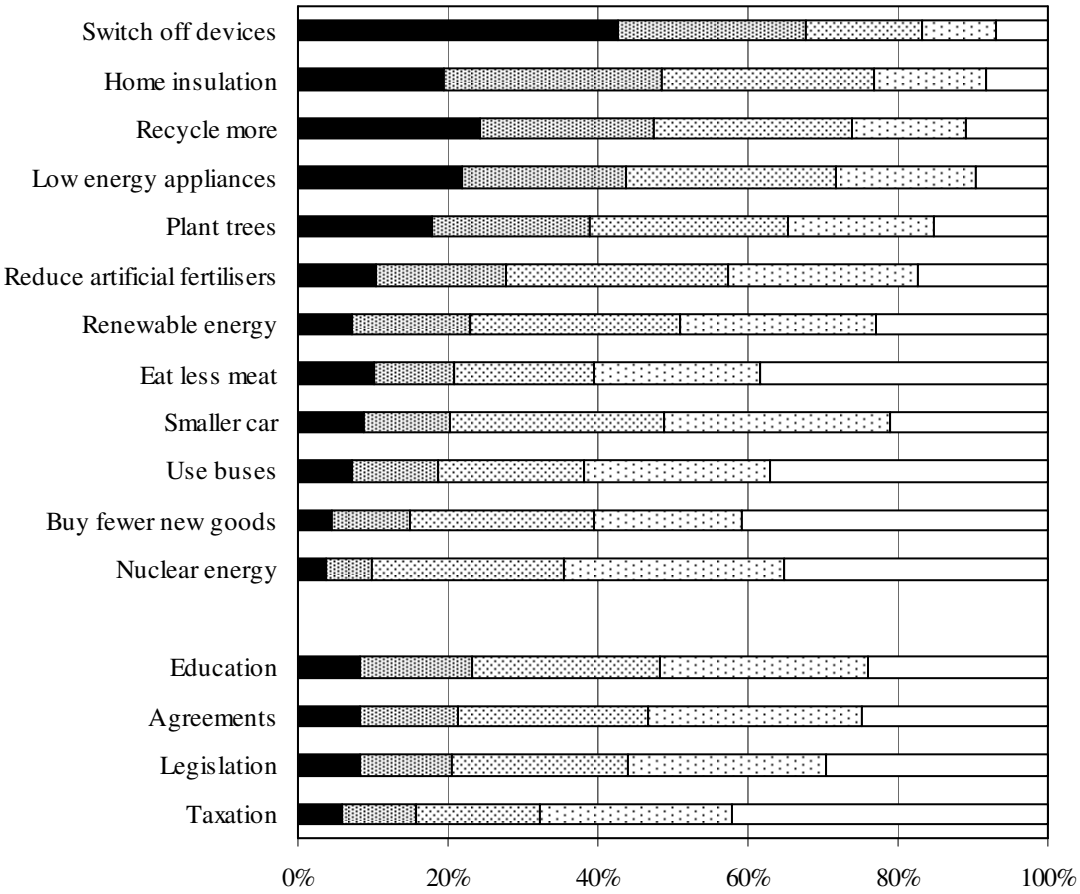


Figure 5 Secondary Students' willingness to undertake various pro-environmental actions, their beliefs about the usefulness of such actions and the relationships between these two measurements.

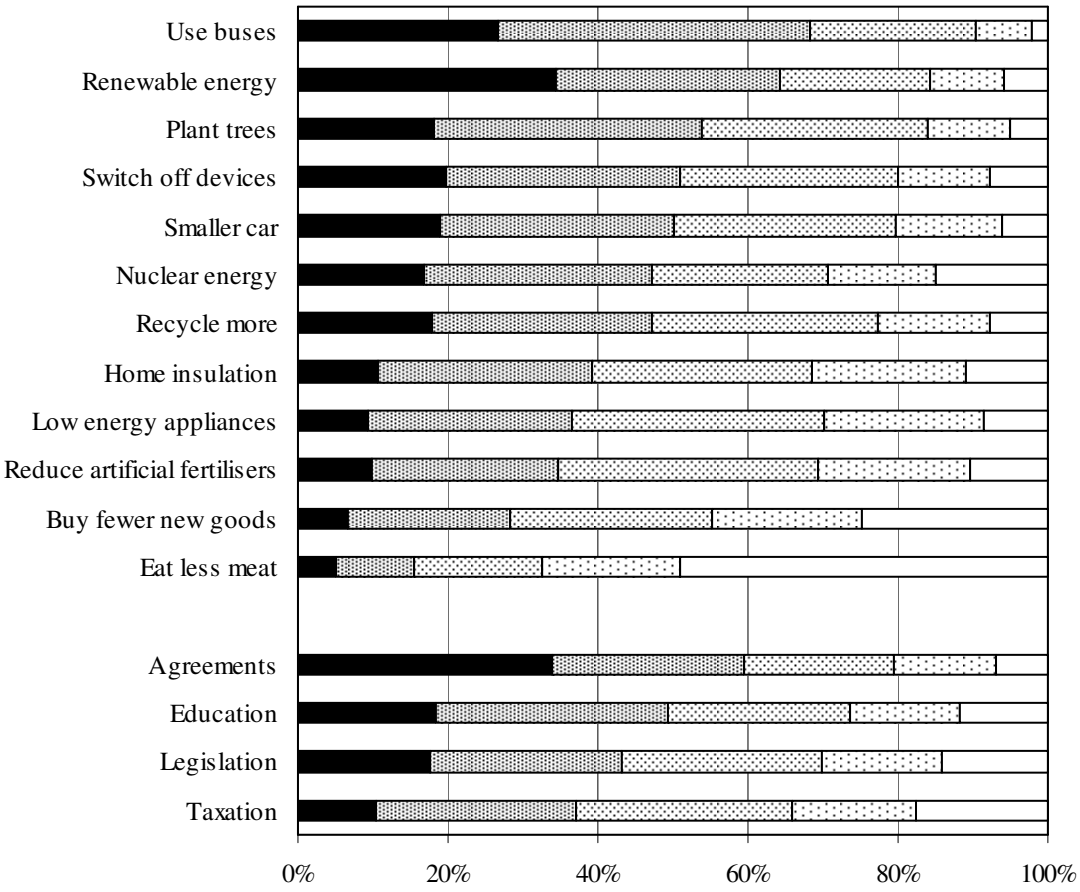
	Degree of Willingness to Act	*Believed Usefulness of Action*	*Potential Effectiveness of Education*	*Natural Willingness to Act*	*Natural Reluctance to Act*	*Potential Usefulness of Education*
	(% 'definitely' + 'almost certainly')	(% 'quite a lot' + 'a fair amount')	(Slope of *Degree of Willingness to Act* plotted vv *Believed Usefulness of Action*)	(Intercept when *Believed Usefulness of Action* is at minimum)	(Measurement between unity and the intercept when *Believed Usefulness of Action* is at maximum)	(*Potential Effectiveness of Education x* proportion of 'perhaps do it' and 'probably not do it')
Direct actions						
Smaller cars	20	50	0.17	0.29	0.54	0.09
Nuclear energy	10	47	0.15	0.20	0.64	0.10
Home insulation	49	39	0.25	0.46	0.28	0.06
Switch off unused devices	68	51	0.14	0.63	0.23	0.02
Plant trees	39	54	0.26	0.36	0.38	0.09
Recycle more	48	47	0.34	0.39	0.27	0.09
Reduce artificial fertilisers	28	35	0.27	0.31	0.42	0.12
Buy fewer new goods	15	28	0.15	0.23	0.62	0.09
Renewable energy	23	64	0.23	0.24	0.54	0.11
Use buses	19	68	0.18	0.19	0.63	0.11
Eat less meat	21	16	0.23	0.27	0.50	0.14
Low energy appliances	44	37	0.25	0.44	0.31	0.07
Indirect actions						
Legislation	21	43	0.23	0.24	0.54	0.13
Taxation	16	37	0.25	0.16	0.59	0.17
Agreements	21	59	0.24	0.23	0.54	0.13
Education	23	49	0.22	0.27	0.52	0.11

Figure 6 Secondary students' *Degree of Willingness to Act* to undertake different pro-environmental actions



For each action, the darkest bar, to the left hand side, represents the percentages of students who would 'definitely' undertake the action; the next, slightly lighter bar those who would 'almost certainly' undertake the action; the next, lighter bar, those who would 'probably' undertake the action; the next bar those who would 'perhaps' take the action; and the right hand, white bar, those who 'probably not' undertake the action. 'Direct' actions are in the upper section of the figure; 'indirect' actions are in the lower section. Within each section, actions are arranged in descending order of the combined percentages of students who would 'definitely' and 'almost certainly' take the action.

Figure 7 Secondary students' *Believed Usefulness of Action* of different pro-environmental actions



For each action, the darkest bar, to the left hand side, represents the percentages of students who responded that the action would reduce global warming by 'quite a lot'; the next, slightly lighter bar those who believe it would reduce global warming by 'a fair amount'; the next, lighter bar, those who believe it would reduce global warming by a 'small but useful amount'; the next bar those who believe it would reduce global warming by 'a very small, hardly noticeable, amount'; and the right hand, white bar, those who believe the action would reduce global warming by 'nothing at all'. 'Direct' actions are in the upper section of the figure; 'indirect' actions are in the lower section. Within each section, actions are arranged in descending order of the combined percentages of students who responded that the action would reduce global warming by 'quite a lot' and by 'a fair amount'.

Figure 8 Comparison of derived indices, *Natural Willingness to Act* and *Potential Effectiveness of Education* for two groups of students, those who are more or less concerned about global warming. The indices and categories are defined in the text.

	Natural Willingness to Act			*Potential Effectiveness of Education*		
Issue	More Concerned	Less Concerned	Sig	More Concerned	Less Concerned	Sig
Direct actions						
Smaller cars	**.40**	**.25**	**	.11	.12	
Nuclear energy	.22	.21		.18	.10	
Home insulation	**.54**	**.44**	*	.20	.23	
Switch off unused devices	**.75**	**.60**	**	.05	.09	
Plant trees	**.50**	**.30**	***	.18	.22	
Recycle more	**.51**	**.36**	**	.28	.28	
Reduce artificial fertilisers	**.41**	**.28**	**	.23	.20	
Buy fewer new goods	**.32**	**.19**	***	.10	.13	
Renewable energy	**.38**	**.18**	***	.14	.21	
Use buses	**.37**	**.15**	**	.07	.11	
Eat less meat	**.38**	**.20**	***	**.11**	**.28**	*
Low energy appliances	**.54**	**.41**	**	.18	.22	
Indirect actions						
Legislation	**.35**	**.21**	***	.20	.10	
Taxation	**.25**	**.13**	**	**.25**	**.11**	*
Agreements	**.32**	**.19**	**	.22	.16	
Education	**.42**	**.21**	***	.13	.15	

*** p<0.001 ** p<0.01 * p<0.05

Environmental education for behaviour change: which actions should be targeted?

ABSTRACT

One aim of environmental education is to enable people to make informed decisions about their environmental behaviour; this is particularly significant with environmental problems that are believed to be both major and imminent, such as global warming. Previous research suggests that there is no strong link between a person's overall environmental awareness and their willingness to undertake pro-environmental actions, so this study focuses on some *specific* issues. Using quantitative methods to investigate students' beliefs about the usefulness of specific actions and their willingness to adopt them, novel indices have been constructed that indicate the potential of education to increase students' willingness to undertake those actions. The findings imply that altering a student's belief about certain issues will have little effect on their willingness to act. This can be because most students, even those with only a weak belief in the efficacy, are prepared to take action anyway. Conversely, it can be because a majority, including those convinced about the efficacy, is not prepared to take action. Support for further use of nuclear power is an example of the latter. Education about such actions, where there is only a weak link between believed effectiveness and willingness to act, may be ineffective in terms of changing practice, because other incentives or disincentives dominate. For such actions other strategies may be required. For another set of actions, however, the benefits of education in changing practice seemed more positive; increasing recycling, reducing the use of artificial fertilisers and planting more trees are examples.

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INTRODUCTION

"The literature on public understanding of climate change indicates widespread awareness of the issue and a general concern, but limited behavioural response"
(Lorenzoni, Nicholson-Cole & Whitmarsh, 2007)

Twenty years ago the scientific evidence for an exacerbation of global warming[1] by a range of anthropogenic atmospheric pollutants was considered by some to be contentious (Stevenson, 1987; Boyes & Stanisstreet, 1993). Today, however, the weight of objective evidence persuades most people that the increase in global warming is a real phenomenon, caused by human-sourced greenhouse gases. Furthermore, authoritative sources agree that this is an increasing threat to the world's environmental integrity, its social well-being (IPCC, 1997; 2001, 2007), economic stability (Stern, 2007) and political security (Solana, 2008). In view of these persuasive predictions, it is increasingly important to design and apply effective measures for reducing greenhouse gas emissions. In part, this will depend on central government policies. The UK government, amongst others, set ambitious targets to reduce by 12.5% (relative to 1990 levels) the levels of the major greenhouse gases by 2010, with a reduction by 20% for carbon dioxide in particular. Furthermore, the political goal is to reduce carbon dioxide by 60% by 2050 (DTI, 2003). Unfortunately, since these targets were set it has become apparent that the 20% reduction in carbon dioxide will not be achieved, throwing doubt on the attainability of the 2050 target of a 60% reduction (DEFRA, 2006).

In a complementary manner, it is estimated that about half of UK energy is used directly by individuals, for domestic use and personal transport. In these sectors, however, energy consumption is increasing (DEFRA, 2008a). What is needed, then, are mechanisms to persuade individuals to reduce their carbon contribution by limiting their energy use, because it is individuals who perform many of the actions that are environmentally significant (Jensen and Schnack, 2006). Although there is controversy about the purposes of environmental education (Heimlich & Ardoin,

[1] In this paper, for economy of words, we use the term 'global warming' to refer to the exacerbation of the natural greenhouse effect by the addition of anthropogenic pollutants to the atmosphere.

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2008), it could be argued that, in view of the urgent call to reduce global warming, one of the aims of environmental education should be to engender in learners a preparedness to act in more environmentally sustainable ways (Mentzer & McEwen, 1999; Jurin & Fortner, 2002). Early models of behaviour change in an environmental context became known as 'information deficit' models (Burgess, Harrison & Filius, 1998). These were based on the assumption that if people understood more about the environment and the actions that would cause, or avoid, environmental degradation, they would behave in a rational manner and adopt environmentally sympathetic practices. In other words, it was believed that there was a relatively direct and positive relationship between a person's cognitive base about environmental problems and their willingness to act in such a way as to reduce these problems. Other models suggested a less direct link in which a decision about action is influenced by situational factors and an intention to act (Hines, Hungerford and Tomera, 1986-7). Some studies have shown that knowledge and behaviour are indeed related (Yencken, 2000). In many other cases, however, it seems that the relationship between knowledge and action is not robust (Rajecki, 1982; Hungerford & Volk, 1990; Posch, 1993; Kollmus & Agyeman, 2002) and it is acknowledged that there is what has come to be known as a 'gap' between cognition and action (Kollmus & Agyeman, 2002). In part, this 'gap' is due to the fact that behaviour is influenced by a plethora of other factors, not just knowledge; other beliefs, social pressures, physical facilitators and inhibitors can synergistically influence whether or not a particular action is pursued (Corraliza & Berenguer, 2000). Similarly, descriptive and injunctive social norms, standards by which actions are perceived as normally being undertaken, or as being approved or disapproved of, can influence whether or not a person acts in an environmentally sympathetic fashion (Cialdini, Reno & Kallgren, 1990). Perhaps most relevant to the present study is the finding that situational influences such as a person's belief in their own self-efficacy also partly determine the extent to which he or she acts in a pro-environmental manner (Devine-Wright, Devine-Wright & Flemming, 2004; Laskova, 2007). Despite these complications, many of these

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other factors are themselves influenced by the cognitive base of the individual concerned, and thus potentially affected by education.

A further issue that has emerged as researchers have attempted to generate models of the incentives and disincentives to pro-environmental behaviour is that there are limitations in studying links between *general* environmental attitudes and potential behaviour patterns (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Dietz, Stern & Guagnano, 1998; Stern, 1992). Given this complexity, and a pressing need for a reduction in the emission of anthropogenic greenhouse gases, we have attempted to explore the role that education about the usefulness of *specific* pro-environmental actions might play in eliciting changes in the practices of individuals. We have designed an instrument that questions respondents about their willingness to undertake *specific* pro-environmental behaviours and, separately, their beliefs about the possible benefits of these particular behaviours in the context of one environmental problem - global warming. Three research questions have been addressed. Firstly, the degrees to which students report being willing to undertake a variety of specific pro-environmental actions have been ascertained. Secondly, the extents to which students believe these particular actions would be effective in reducing global warming have been investigated. Thirdly, the relationship between these two parameters, students' reported willingness to undertake specific actions and their beliefs about the usefulness of the same actions, has been explored. In addition, measures were sought of students' degree of concern about global warming, and the extent to which they thought that it was a real phenomenon. The overall aim was to determine the extent to which increasing students' understanding about the efficacy of specific actions might be in persuading individuals to increase their willingness to undertake those actions, so that education for changes in practice might be targeted for greatest efficacy.

METHODS

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This study employed a novel questionnaire to probe the views of secondary students. The study was initiated in the UK, but has since extended to Australia, the USA and a number of countries in mainland Europe; here we report the findings of the UK study.

Design of the questionnaire

The questionnaire consisted of a coversheet, two main sections and a short final section. The wording of the questionnaire items from the two main sections is shown in Figure 1, where the ordering is different to that in the questionnaire for the reasons given below. The coversheet asked respondents to record their grade and gender, and the fourth section, at the end of the questionnaire, contained 4 items designed to probe the level of students' concern about global warming, the extent of their perceived knowledge about global warming, the degree to which they considered themselves to be environmentally 'friendly', and whether or not they believed that global warming was a real phenomenon that was already happening. These questions, and the available responses, are shown in Figure 2.

The first of the two main sections of the questionnaire contained 20 items, 16 of which were about actions that would contribute to the amelioration of global warming. Most of the ideas in these items 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 concerned indirect actions, such as supporting increased environmental taxation or legislation. The four remaining items were more idiosyncratic in nature; these focused on ideas that had been raised by students themselves in earlier research (Boyes & Stanisstreet, 1993). These four distracters were added to the 16 so that respondents would not feel obligated to respond positively to all questions (Oppenheim, 1992; Parmenter and Wardle, 2000); the results from these four items will not be considered in this paper.

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The focus of the first main section of the questionnaire was the degree to which students would be willing to undertake a particular action, in the words of the coversheet of the questionnaire, "for the sake of the environment and the future of the Earth"; no mention was made of global warming at this stage. Each item took the form of a conditional clause indicating the personal cost or inconvenience of the action, followed by a simplified description of the action. The wording of the items can be seen in the right hand column of Figure 1, and the available responses to these items, which ranged from "I would definitely do it" to "I would probably not do it", and the ways in which they were scored, are shown in the right side of Figure 3. The scored responses produced by the items in this section of the questionnaire were designated students' *Degree of Willingness to Act*.

The 20 items in the second main section of the questionnaire concerned the same pro-environmental actions as those in the first main section, although the order was different so that the pairing of the questions was not immediately apparent to the respondents. Here, however, the focus of the questioning was on the extent to which respondents believed that the actions were useful in alleviating global warming. The wording of these items can be seen in the left column of Figure 1, and the available responses, which ranged from "quite a lot" to "nothing at all really", and the ways in which they were scored, are shown in the left side of Figure 3. The scored responses were designated students' *Believed Usefulness of Action*.

Figure 1 also illustrates the pairing of the items and the themes within the questionnaire. Not only were the items paired, however, the available responses in the two main sections of the questionnaire were designed to 'match', in semantic terms. Figure 3 illustrates this, where the two response scales are shown in apposition. If, for example, a student believed that a particular action would help by 'quite a lot', this was matched in the other section to the response that they would 'definitely' be willing to do it; each of these responses received a score of 1. Conversely, if a student believed that an action would reduce global warming 'by nothing at all', this is matched to

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the action section response that they would 'probably not' do it, and both responses received a score of zero. The intermediate responses were also designed to correspond in a similar way, semantically and by score.

The final wording of the paired questionnaire items and matched response scales came about from a series of discussions with a group of researchers and teachers. The questionnaire was trialled with 134 students (age 14 years), and the only modification entailed the removal of the word 'insulation' and the rephrasing of the pair of questions concerned.

Construction of the indices

From the responses to the two main sections of the questionnaire, the *Degree of Willingness to Act* and *Believed Usefulness of Action*, a number of derived indices were produced that have been used to explore the connections between them. Although the two response scales are ordinal and although they measure different things, it was felt that because of their semantic matching (Figure 3), some mathematical manipulation of the data is acceptable; this will be explored below.

Potential Effectiveness of Education

The indices we wish to focus on here relate to the extent to which increasing the understanding about the efficacy of a particular action through specific environmental education might persuade individuals within a cohort to undertake that action. To obtain these for a particular action, student measures of the *Degree of Willingness to Act* were plotted against their value of the *Believed Usefulness of Action*, and the trend line was fitted. This produced a graph of the type exemplified in Figure 4. The semantic matching of the responses means that linear regression is less sensitive to the errors involved in using ordinal scales. The slope of such a trend line indicates the extent to which the willingness of students to undertake an action might be said to be dependent upon their belief in the usefulness of that action. The gradient, therefore, provides a measure of the extent to

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which willingness to undertake an action might be increased by persuading students of the environmental effectiveness of that action; we have called this gradient, in the present context, the *Potential Effectiveness of Education*. Once the gradient of the line has been determined for a pair of questions, two other derived indices can be calculated from the intercepts. The intercept when the *Believed Usefulness of Action* is zero represents the likely action of those students who believed that such an action would be ineffective in reducing global warming; we term this the *Natural Willingness to Act,* and Figure 4 is annotated to show this. In a complementary fashion, the distance marked *Natural Reluctance to Act* in Figure 4 is a measure of the extent to which students will not take action, even though the *Believed Usefulness of Action* is at its maximum. These three indices may be useful in comparing the potential effect of education about different specific pro-environmental actions in terms of changing practice.

Comparing the values of the *Potential Effectiveness of Education* for different actions gives an indication of those actions for which education about their potential effectiveness might lead to an increased willingness to undertake the action, and other actions where education will probably be less effective in this role. On a population basis, however, there is another measurement that will influence the efficacy of education to this end, namely the proportion of the population who are not already reporting an intention to take action. Thus, education might be most productive in terms of changing individuals' practices if directed at those actions that relatively few of the population are already willing to undertake. A final index was therefore calculated, the *Potential Usefulness of Education*, by multiplying the *Potential Effectiveness of Education* by the proportion of students in who would 'probably not' or only 'perhaps' undertake the action.

RESULTS

In all, 961 students in Grades 6 (11-12 years old) to 10 (15-16 years old) (UK National Curriculum Year Groups 7 through 11) from four state Community Comprehensive schools in the North West

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of England completed the questionnaire. Of this sample, 18% were in Grade 6, 23% were in Grade 7, 25% were in Grade 8, 17% were in Grade 9, and 17% were in Grade 10. Males comprised 52% of the cohort, females 48; males and females were evenly distributed over the years. The responses to the final four questions provided some background information about the beliefs and views of the students. Some 61% of the students thought or were sure that global warming was happening, with half of this figure (31%) being sure of this. About half of the students expressed concern about global warming, with 16% reporting being 'very worried' and a further 33% reporting being 'quite worried'. Few students, about 14%, thought that they were well informed (knew 'a lot') about global warming, although a further 39% considered they knew 'something' about it. Nearly half of the cohort (45%) thought of themselves as being either 'very' or at least 'quite' environmentally friendly. Thus, many of this group of students believed that global warming is a real phenomenon, few thought that they were especially well informed about it, and about half were concerned about its consequences.

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Students' *Degree of Willingness to Act*

The findings concerning students' *Degree of Willingness to Act* for different pro-environmental actions are given in the first column of Figure 5 and illustrated graphically in Figure 6. In Figure 6, the items are arranged in descending order according to the combined percentages of students who would 'definitely' or 'almost certainly' undertake the action; in the descriptions below, these same percentages are reported. The direct action to which most students were amenable (68%) was to switch off un-used electrical appliances. The prospect of installing home insulation was acceptable to about half of the students (49%), as were the ideas of recycling materials (48%) and paying more for energy-efficient domestic appliances (44%). Over a third of the cohort (39%) were willing to pay for more tree-planting, although fewer (28%) would accept the increased price premium for food grown without artificial fertilisers, and even fewer (21%) would be prepared to reduce their consumption of meat. In terms of personal transport, only about a fifth of the students (20%) would

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consider getting a smaller car and a similar proportion (19%) would accept reducing car use by using public rather than private transport. Rather few of the students (15%) would accept buying fewer fashion items. In terms of energy production, few students (10%) felt that using nuclear power was acceptable and, perhaps surprisingly, relatively few (23%) would consider paying more for renewable energy sources. Most of the indirect actions were also unpopular. Only about a quarter of the students would be prepared to undertake more education about environmental issues (23%) or allow their vote to be influenced by support for new environmental legislation (21%), international agreements (21%) and, for even fewer, increased environmental taxation (16%). Thus, students appeared willing to undertake different environmental behaviours to varying extents. There was a strong association between most of the 16 *Degree of Willingness to Act* items and the question in the third section of the questionnaire about the extent to which students were worried about global warming. This will be discussed later.

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Students' *Believed Usefulness of Action*

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Items in the second main section of the questionnaire explored students' beliefs about the usefulness of the various actions in reducing global warming, their *Believed Usefulness of Action*, and the data from the responses are given in the second column of Figure 5 and illustrated graphically in Figure 7. In Figure 7, the items are arranged in descending order according to the combined percentages of students who thought that the action would reduce global warming by 'quite a lot' or by 'a fair amount'. In the descriptions that follow, these same percentages are reported. Students apparently made a link between global warming and personal transport; two actions thought by many of the students to contribute to a reduction in global warming were to reduce car use (68%) and drive smaller cars (50%). Energy production also seemed to be linked with global warming in students' minds, since many believed that production of energy from renewable sources (64%) and from nuclear sources (47%) could play a role in reducing global warming. Perhaps linked to this, another relatively popular idea was energy conservation by

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switching off unused electrical items (51%). Surprisingly, rather fewer students realised that installing home insulation (39%) or the use of energy-efficient domestic appliances (37%) could reduce global warming. Tree planting was also thought to contribute to decreasing global warming by more than half of the students (54%), and almost as many (47%) appreciated the role that increased recycling could play. Rather fewer of the students (35%) realised that reducing the use of artificial fertilisers and decreasing meat consumption (16%) could lessen global warming, perhaps because the mechanisms involved gases other than carbon dioxide, the latter being perhaps the most well-known greenhouse gas. Just over a quarter of the students (28%) appreciated that buying fewer new items could help to reduce global warming. Of what we have termed the 'indirect actions', those related to international agreements were thought to be the most effective (59%), with education (49%), legislation (43%) and taxation (37%) being thought less so. Thus, students believed that the various environmentally-friendly actions that had been suggested in the questionnaire would be differentially effective in reducing global warming.

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Relationship between the *Degree of Willingness to Act* and *Believed Usefulness of Action*

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As explained above, a number of indices can be obtained from the responses to the two main sections of the questionnaire, where the scored items were called the *Degree of Willingness to Act* and the *Believed Usefulness of Action*. Some of these will now be discussed.

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The *Potential Effectiveness of Education* provides an indication of the extent to which increasing understanding about particular actions through specific environmental education might persuade individuals to undertake those actions. This relationship was quantified by linear regression, and the results are illustrated schematically in Figure 4; the values of the indices from the regression are summarised in the last four columns of Figure 5. The first of these, the slope of the regression line constructed when the *Degree of Willingness to Act* and the *Believed Usefulness of Action* for pairs of actions are plotted, has been designated the *Potential Effectiveness of Education*; a high value of

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this index represents a steep relationship between the extent to which students believe an action to be effective and their willingness to undertake that action. In such cases, persuading students of the efficacy of the action should result in more students purporting to take that action. Where the relationship is shallower, indicated by a lower value of the *Potential Effectiveness of Education*, education about the action is less likely to result in more students from this cohort adopting it. The other two indices, the two vertical dimensions marked in Figure 4, provide indicators of the extent to which students will undertake the action anyway, without believing in its effectiveness (*Natural Willingness to Act*), and of the extent to which students will avoid the action even if they believe it is highly effective (*Natural Reluctance to Act*); they each take a value between zero and one.

Figure 5 shows that for some actions the value of the slope of the line, the *Potential Effectiveness of Education*, was low, suggesting that there was little change in the willingness to undertake an action for different beliefs in the effectiveness of that action. For example, this was true for the action of switching off unused electrical items (0.14). In this case, the slope of the line was shallow because the *Natural Willingness to Act* was relatively high (0.63); students were prepared to take this action in any case. In this case it is likely that other motivators, such as reducing electricity bills, coupled with a relatively low level of inconvenience, meant that students would be taking this action anyway. The value of the *Potential Effectiveness of Education* was also fairly low for some other actions such as adopting more nuclear power (0.15), reducing car use (0.18), avoiding buying new fashion items (0.15) or purchasing smaller cars (0.17). In these cases, however, the slope of the line was shallow because the *Natural Reluctance to Act* tended to be quite high; even if students believed these actions to be effective in reducing global warming, they seemed unwilling to undertake them. In these cases it is probable that other disincentives, such as major inconvenience, substantial changes in lifestyle or concerns over nuclear energy, would prevent students taking these actions even though they believed that the actions could make a substantial contribution to the reduction of global warming. In yet other cases there was a steeper association between a belief in

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the effectiveness of an action and a willingness to undertake it. Increasing the amount of material that is recycled (0.34), reducing the use of artificial fertilisers (0.27) and tree planting fell into this category (0.26). In these cases, the *Natural Willingness to Act* and the *Natural Reluctance to Act* were both relatively low, and so the slope of the line was fairly steep. For these specific actions, then, education that persuades students of the effectiveness of the action might well result in more of the students adopting the action. In summary, there are some pro-environmental actions that will probably not be induced by convincing students of their efficacy, and there are other, different, environmentally sympathetic actions that may well be encouraged by persuading students of their effectiveness.

There is one other factor that will impinge upon the degree to which environmental education might be effective on a population level. The overall effectiveness of such education will be maximised when directed at those actions that a high proportion of the population are not already undertaking. In an attempt to give some quantitative comparison to the various actions raised in the questionnaire, a final index, the *Potential Usefulness of Education,* was constructed by multiplying the *Potential Effectiveness of Education* by the proportion of students who would 'probably not' or only 'perhaps' undertake the action; these data are shown in the final column of Figure 5. This multiplication produces much smaller numbers, but the bigger of these indicate that teaching about the effects of reducing meat consumption (0.14), lowering the use of artificial fertilisers (0.12), decreasing car use (0.11) and increasing the proportion of energy generated from renewable sources (0.11) should be useful areas on which to concentrate teaching.

Differences between subsets of students

Differences between various groupings of students were investigated in a number of ways. ANCOVA was used for the basic scores on the 32 items when exploring, simultaneously, differences between the responses of male and female students, and students in different grades.

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ANCOVA can be used not only to analyse the effect of several categorical independent variables on a dependent variable (ANOVA) but can include one or more continuous variables which may predict the dependent variable. In this case grade is used as a more or less continuous variable. For the derived indices, gradient and intercept were compared for any two groups using the standard technique of dummy variable creation and fitting a multiple linear regression model against the independent variable, the comparison variable (dichotomous) and the derived variable. Differences from any of these tests are noted below. When discussing these differences, the percentage of the top two categories will be reported for the main questions (defined as in the first two columns of Figure 5), whereas the derived indices will simply have their values compared (explained in the later columns of Figure 5).

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Differences between male and female students

In this section, the first figures in brackets will be those first for the males, followed by those for the females. For the *Degree of Willingness to Act* items, more females than males were prepared to take action on some issues; this included switching off unused electrical items (65%, 71%, $p<0.05$), reducing car use (15%, 23%, $p<0.05$) and eating less meat (15%, 27%, $p<0.001$). In the case of items to determine the *Believed Usefulness of Action*, three issues showed that females once again had a greater belief in using energy-efficient domestic white goods (33%, 40%, $p<0.01$), reducing the purchase of new fashion items (26%, 31%, $p<0.05$) and taking into account a politician's willingness to legislate on the environment when voting (38%, 48%, $p<0.01$).

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Measures of the *Potential Effectiveness of Education*, showed only one difference between the genders and that was for the question relating to international agreements (0.15, 0.33, $p<0.01$), where females appeared more likely to have their behaviour influenced by their understanding or belief. For two issues there were significant differences in the *Natural Willingness to Act*; for eating less meat females showed a greater inherent compliance (0.22, 0.31, $p<0.001$), but they

seemed less naturally willing to vote in accordance with politicians' views on international environmental agreements (0.29, 0.15, p<0.01).

Differences between students in different grades

Differences between students in different grades are reported below only if ANCOVA revealed statistically significant differences giving a trend across the grades. In the descriptions that follow, the percentage figures quoted are for the top two categories of response across Grades 6, 7, 8, 9 and 10. Within the 16 *Degree of Willingness to Act* items, there were 6 significant and reasonably consistent trends downwards across the grades. These were switching off unwanted appliances (81%, 65%, 63%, 69%, 66%, p<0.01), purchasing foods cultivated without artificial fertilisers (34%, 35%, 18%, 30%, 24%, p<0.001), eating less meat (28%, 28%, 14%, 16%, 19%, p<0.001), buying more efficient appliances (56%, 46%, 36%, 45%, 40%, p<0.001) and voting for politicians in light of their policies on 'green' legislation (34%, 24%, 14%, 18%, 17%, p<0.001) and their support for international environmental agreements (36%, 21%, 15%, 20%, 18%, p<0.001).

In the other main section of the questionnaire, the *Believed Usefulness of Action*, there were also a number of differences that for the most part showed a decrease over the grades. So, fewer of the older students believed that global warming would be reduced (by 'quite a lot' or by 'a fair amount') by adopting the use of smaller cars (57%, 55%, 52%, 51%, 33%, p<0.001), insulating homes (44%, 45%, 42%, 39%, 21%, p<0.001), switching off un-used electrical items (61%, 57%, 48%, 48%, 39%, p<0.001), recycling more (54%, 60%, 47%, 37%, 33%, p<0.001), helping to reduce the use of artificial fertilisers (35%, 46%, 37%, 29%, 22%, p<0.001), buying fewer fashion items (35%, 33%, 27%, 25%, 21%, p<0.001), reducing car use (76%, 70%, 65%, 71%, 58%, p<0.001), eating less meat (19%, 21%, 16%, 8%, 10%, p<0.001) or using energy-efficient domestic appliances (47%, 42%, 31, 39%, 25%, p<0.001). Confidence in the effectiveness of most of the indirect actions also declined over the grades. Thus, fewer of the older students saw the benefit,

with regard to global warming, of voting in accordance with promises on environmental legislation (53%, 46%, 38%, 45%, 36%, p<0.01) and taxation (47%, 38%, 34%, 38%, 27%, p<0.001), and international agreements (72%, 60%, 55%, 60%, 51%, p<0.001).

There were a number of differences across the grades in the *Potential Effectiveness of Education*, as tested using two groups of students (top two and bottom two grades) and the standard technique described earlier. Generally, the analysis showed increases in the *Potential Effectiveness of Education* across the grades; this included the actions of planting trees (0.19, 0.16, 0.21, 0.28, 0.50, p<0.05) and increasing adoption of renewable energy (0.16, 0.23, 0.09, 0.24, 0.38, p<0.05). Although it is known that the knowledge-behaviour link is weak (Kollmus & Agyeman, 2002), it would appear from these findings that it is stronger for the older students, and would suggest perhaps that persuading older school students of the effectiveness of these specific actions might be more effective than teaching younger students. This trend was also evident in two of the indirect actions, related to supporting international agreements (0.16, 0.20, 0.11, 0.19, 0.43, p<0.05) and being prepared to undergo more environmental education (0.19, 0.10, 0.18, 0.25, 0.36, p<0.05). However, it was also noticed that for these, and only these issues, the *Natural Willingness to Act* started high and decreased across the grades, as the *Potential Effectiveness of Education* increased. The conclusion would seem to be that adolescents' views retain a degree of flexibility about these issues, with younger students being generally less discriminatory, and having a high willingness to act regardless of their belief in the efficacy of an action. Older students seem to show a response in their intended actions which is more in line with their understanding, again suggesting that teaching about these issues might be best targeted at older students.

Differences between more and less concerned students

Finally, the relationship between the extent of students' concern about global warming and their willingness to act in various pro-environmental manners was investigated. Students were grouped

according to their responses to a question in the final section of the questionnaire about how worried they are about global warming. Those who indicated that they were 'very' or 'quite' worried were considered to be 'more concerned' (n=452); those who responded that they were 'a little bit worried' or 'not worried at all' were considered to be 'less concerned' (n=460).

Rather than examine how these two groups responded to the *Degree of Willingness to Act* variables directly, which inevitably contain information about students with different degrees of *Believed Usefulness of Action*, we elected to focus on the extent to which being more or less worried might affect one's inherent willingness to take action. When the 16 regressions were performed for each of these two groups, and the indices compared using the dummy variable technique mentioned earlier, it became apparent that the values for the *Natural Willingness to Act* indices were consistently higher for the more concerned students than for those who were less concerned; this was true for all actions other than the increased adoption of nuclear power. Figure 8 shows the details for all the differences measured, where one may recall that the *Natural Willingness to Act* mapped on to the 5 values from zero to one. In contrast to these differences, only two of the values of *Potential Effectiveness of Education* showed statistically significant differences between the two groups, and these differences were relatively small. It seems clear from Figure 8 that, regardless of the degree of worry about global warming, the sense in which action might be influenced by understanding or belief is fairly stable, though different for each issue. On the other hand, the *Natural Willingness to Act*, the likely action even when it is believed to be ineffective, is significantly greater for almost all issues for those who are more concerned about global warming. Interestingly, the biggest differences are related to transportation, namely the use of smaller cars (0.40, 0.25, $p<0.01$) and the use of public transport instead of cars (0.37, 0.15, $p<0.01$). Whether or not action is likely seems to be little affected by belief (the *Potential Effectiveness of Education* is small whether students are worried or not) and, as noted above, these issues demand behaviour changes that affect people's personal freedom and status. Worry about global warming, on the

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other hand, does seem to have some impact on action in this area. It has been suggested by research on air pollution (Boyes, Stanisstreet, Myers, Skamp & Yeung, 2007) that fear or worry, particularly for western students, has a considerable influence on their stated willingness to take certain environmental actions. In this case it would seem to be relatively independent of what students believe or understand about the effectiveness of that action. Thus it would appear that the worry about global warming and its consequences might precipitate action, even if that action is thought unlikely to be helpful; perhaps such actions are viewed as a kind of insurance policy.

The one exception from Figure 8 is for the idea of being willing to pay more for electricity if it were produced by nuclear power. The *Natural Willingness to Act* in this way was small (approximately 0.2) and is essentially the same for both groups of students. This suggests that there are other concerns which, in the case of nuclear power, take precedence.

DISCUSSION

Approximately two thirds of the students in this study believed that global warming is a real phenomenon, paralleling the high general awareness of global warming in the adult population (MORI, 2004). Furthermore, about half of the respondents expressed concern about the consequences of global warming, again similar to the adult population (PEW Research Centre, 2009), suggesting that consciousness of, and concern about, global warming are beginning to develop early. Perhaps because of anxiety about global warming, UK adults in general appear to support, in principle at least, both individual and political action to reduce global warming (BBC, 2007); about half of the UK population believe that modifying individuals' practices would diminish global warming. In a complementary manner, a proportion of the population in general would support the introduction of further environmental legislation, partly because this is seen as fairer, but also because it means that pro-environmental behaviour does not rely only on an individuals' willingness to act (Darier & Schule, 1999).

Deleted: **Differences between subsets of students**¶
Differences between various groupings of students were explored in a number of ways. ANCOVA was used for th ... [19]
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In the context of these general attitudes, the findings of the present study indicate that among UK secondary students there is a differential willingness to undertake different pro-environmental actions - what we have termed the *Degree of Willingness to Act*. Among the more direct actions, many students report a willingness to switch off unused electrical items in the home, whereas far fewer are prepared to alter their practices concerning personal transport by using public rather than private transport, or by accepting the use of smaller, more energy-efficient private vehicles, unless they are particularly worried about global warming. The differential willingness to undertake diverse pro-environmental actions is similar to that reported for adults, who are more prepared to increase recycling or to take action to conserve energy in domestic situations, but less willing to modify their travel habits (Shackley, McLachlan & Gough, 2004; Kasemir *et al*, 2003; O'Connor, Bord & Fisher, 1999). Each of the pro-environmental actions raised in this study has associated incentives and disincentives for young people, the nature and extent of which will differ between different actions. These motivators and inhibitors stem from a plethora of sources, including beliefs, the ability to act (Jensen & Schnack, 2006), social pressures (Cialdini, Reno & Kallgren, 1990), social background (Pruneau *et al*, 2007) and characteristics of the physical context (Corraliza & Berenguer, 2000). Thus, the likelihood of undertaking any particular pro-environmental action is the result of an interaction between a general feeling of benefiting the environment, coupled with more concrete personal incentives, disincentives and concerns. Switching off un-used electrical items, for example, causes only minor inconvenience so carries few such inhibitors. In addition, it may carry an incentive in that it aligns with parental exhortations to 'save electricity' for financial reasons. Use of public transport, on the other hand, may be perceived as carrying a major inconvenience and could be associated with a negative social image amongst school students' peer groups, with social norms acting as a disincentive (Cialdini, Reno & Kallgren, 1990). For indirect actions such as the influencing of voting patterns, rather few of the students seemed willing to consider increased environmental taxation, legislation or education or, perhaps surprisingly, even

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international agreements. Whilst it is unclear what voting priorities young people may have, a part of their general unwillingness to consider such issues may be because there is a tendency for them to distrust politicians (Smith, Stanisstreet & Boyes, 2005) and other authority figures (Stern, 2008). Such mistrust has major implications for a population that approves in principle of the introduction of pro-environmental actions by central government, but seems less willing to take this into account when voting.

The findings of the present study also indicate that students consider that different actions may have different levels of usefulness in reducing global warming, a measurement we termed the *Believed Usefulness of Action*. For example, reducing car use, generating electricity from renewable sources and switching off un-used electrical items were thought to contribute to reducing global warming. In addition, tree planting was seen as useful in this context. The prime effect of all of these actions relate to atmospheric carbon dioxide, either by decreasing carbon dioxide emissions or, in the case of tree planting, by increasing the rate of removal of carbon dioxide from the atmosphere.

Reducing the use of artificial fertilisers or decreasing the use of meat production was thought by students to be less effective. In these cases the greenhouse gases involved are nitrogen oxides and methane, respectively. It may be that the efficacy of such pro-environmental actions in terms of global warming may be less well appreciated because the contribution of these two gases to global warming is less well known than that of carbon dioxide (Boyes & Stanisstreet, 1993, 2001), the role of which has been more recently re-enforced by phrases such as 'carbon footprint', 'carbon dependency' and 'carbon trading'. Students were also not strongly aware of the link between consumption of new 'fashion' items and global warming, perhaps because the energy consumed in their manufacture and transport to the point of purchase does not come immediately to the minds of young people.

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By combining the data obtained from the two main sections of the questionnaire, the *Degree of Willingness to Act* and the *Believed Usefulness of Action*, it was possible to derive a series of novel indices to gain insight into the probable advantage, in terms of changing students' practices, of persuading young adults of the efficacy of different pro-environmental actions in ameliorating global warming. In particular, the *Potential Effectiveness of Education* is a measure, in the context of the present study, of the association between belief in the effectiveness of an action and the willingness to undertake it. Certain actions had rather low values for the *Potential Effectiveness of Education*, indicating that education might be less effective for such actions in terms of behaviour change. There are two reasons why the *Potential Effectiveness of Education* might be low. In some cases, such as switching off un-used electrical items, this was because students showed a high *Natural Willingness to Act* - they would perform such actions irrespective of a belief or not in their merit. In other cases a low *Potential Effectiveness of Education* was associated with a high *Natural Reluctance to Act.* Here, even a relatively strong belief in the efficacy of an action did not promote its uptake, presumably because there were other disincentives in place; the nature of such disincentives would, of course, vary between different actions. For example, adoption of nuclear power may show a high *Natural Reluctance to Act* because of fears about environmental or health impacts of nuclear power. Change in transport habits, such as the use of smaller cars or substitution of public for private transport, could be somewhat intractable because environmental sensitivity would be out-weighed in decision-making by preferences about lifestyle or personal convenience, an example of a physical inhibitor acting as a disincentive (Corraliza & Berenguiar, 2000). In addition, students were resistant to reducing their purchase of new 'fashion' items, perhaps because consumption of this sort is perceived as a natural characteristic of their western life-style. In such cases, where the *Potential Effectiveness of Education* is low, education alone might be of only limited benefit in terms of altering students' actions, although it might be a useful component in a series of measures. For example, introduction of potentially unpopular environmental legislation might be made more acceptable if there is a general understanding of why it is necessary.

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In the case of other pro-environmental actions, there was a stronger relationship between the extent to which an action was believed to be effective in reducing global warming and a willingness to undertake it; in other words, the *Potential Effectiveness of Education* was higher. Increasing recycling, reducing the use of synthetic fertiliser, tree planting, installing home insulation and using energy-efficient domestic appliances were examples of these actions. The first of these might be especially relevant because this action is within the locus of control of individual young people. Indeed, it has been shown that in the case of health education (Wilcox *et al*, 1981: Croucher *et al*, 1985), young people may influence the practices of the family in which they live, even though the effect may be weak.

With virtually all of the issues, the rate at which intended action increased with belief about that action did not depend on how worried the students were about global warming. On the other hand, the extent to which the more worried students were prepared to take action even when they did not believe it to be effective, was considerably greater; that is, the *Natural Willingness to Act* was greater in the more concerned individuals. One possible explanation is that the more concerned students make an assessment that, even though they perceive the action as having little or no effect, it is worth taking 'just in case', because they worry about the outcome being so devastating. The one issue that did not follow this pattern was the idea of being willing to pay more for electricity if it were produced by nuclear power. The perceived risk of global warming seems to pale into insignificance compared to the risk assessment made for the proliferation of nuclear energy in the minds of even those students who are concerned about global warming. Alternatively, a willingness to take action and a concern about the consequences of global warming may represent a 'constellation' of attitudes (Heimlich & Ardoin, 2008), underpinned by such students' perception of themselves as being 'pro-environmental'.

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Not all of those who are at present unwilling to undertake actions will be persuadable to change their practices. The adult population can be considered to consist of various 'segments' with different characteristic behaviours and attitudes, and members of some of these segments are resistant to change practice (DEFRA, 2008b). Members of other segments are more amenable to change however. A further index, the *Potential Usefulness of Education*, attempted to take account of the size of the potential education audience, that is, the proportion of students who did not already intend to undertake such actions. Actions with a high *Potential Usefulness of Education* were those for which intended behaviour appeared to be strongly influenced by a belief in their effectiveness (that is, the *Potential Effectiveness of Education* was high), and which a relatively high proportion of students are at present unwilling to undertake. Using this index, certain specific actions emerge as useful targets for education: a reduction in meat consumption (and therefore production) and a willingness to pay more for produce grown without the use of artificial fertilisers, together with a decrease in car use and production of energy from renewable sources were such actions. Furthermore, as above, the first two of these are under at least partial control of the individual concerned.

This study reveals that for different actions there is a different degree of association between a belief in the efficacy of an action and a willingness to undertake it; this variation is one reason why environmental education in *general* terms might be less than fully effective in terms of behaviour. Even in the case of specific actions, it is apparent that for some actions education to persuade learners of their usefulness in terms of a major environmental problem has little potential on its own to be effective in terms of modifying young people's practices.

The present findings suggest that where there were differences between the responses of male and female students, females tended to be more sensitive to the benefits of certain pro-environmental actions, and more willing to undertake other pro-environmental actions. This is congruent with the

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observation that females tend to score more highly than males on instruments that measure of environmental attitudes (Burger *et al*, 1998; Taskin, 2009). The results also indicate that the degree of association between belief in the effectiveness of an action and a willingness to undertake it differs across different age groups of students. It appears, in contrast to our intuition, that older secondary students might respond more to teaching than their younger counterparts in terms of behaviour change. Perhaps a potential hazard, then, of initiating education about pro-environmental actions too early might be that of over-exposure; the possibility is that by the time that students reach their most receptive stage they may be in a state of environmental 'fatigue', in the same way that donors to charity are thought, eventually, to suffer 'compassion fatigue'. In addition to this heterogeneity that could be linked to overt independent factors such as gender and year group, it appears that there is an association between the level of concern among students about global warming, and their willingness to undertake pro-environmental actions. Education strategists and practitioners should be aware, therefore, of this further heterogeneity within the student population; like adults (Lorenzini, Nicholson-Cole & Whitmarsh, 2007; DEFRA, 2008b), students will not be uniform in their behavioural responsiveness to environmental education even about specific actions.

Research of this nature inevitably suffers from limitations. For example, there may not always be a strong correlation between a stated intention to act and an actual change in practice (Downing & Ballantyne, 2007). Furthermore, whether or not an action is undertaken is partly dependent on action competences (Jensen and Schnack, 2006). Despite this, it is still advantageous to explore the stated intentions of the upcoming generation, and so we have sought to elicit the opinions of students concerning their beliefs about the usefulness of certain actions in reducing global warming and their reported willingness to undertake them. In addition, this study has derived novel indicators of the likely usefulness of education in increasing the willingness to undertake specific actions. The discrepancies between belief and willingness to act for different actions originate in the variety of other, sometimes non-environmental, incentives and disincentives associated with the

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(Jensen and Schack, 2006), and a student's knowledge base is only one component of this.

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various actions. It would be interesting, in further research, to investigate the detail of those things that restrain or encourage individual actions, remembering that a wide variety of factors are likely to be involved, and that these will differ for each action under consideration.

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Figure 1 Wording of the questionnaire items. The main items of the questionnaire displayed so that the 'pairing' of the items can be seen.

Themes	Items about the *Believed Usefulness of Action*	Items about the *Degree of Willingness to Act*
Direct actions		
Transport (use)	If people didn't use their cars so much, 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
Transport (type)	If people had smaller cars that used less petrol or diesel, global warming would be reduced	Even if it was not as fast or luxurious, I would try to get a car that uses less petrol or diesel
Power generation (renewable)	If more of our energy was produced from the wind, waves and sun, 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
Power generation (nuclear)	If more of our energy was produced from nuclear power stations, 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
The home (electricity use)	If people used less electricity in their homes, global warming would be reduced	To save electricity, I would switch things off at home when I didn't need them
The home (insulation)	If people got their homes insulated better, global warming would be reduced	Even though it cost me money, I would get extra insulation for my home
The home (consumer durables)	If people got things for their homes (like fridges and washing machines) that used less energy, 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
The home (consumables)	If people were prepared to buy fewer new things and make do with the old ones, 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
Environmentally-friendly (trees)	If more trees were planted in the world, global warming would be reduced	Even if I had to pay more taxes, I think there should be more trees planted in the world
Environmentally-friendly (recycle)	If people recycled things more, global warming would be reduced	Even if it was more trouble for me, I would recycle things rather than just throw them away
Food (Reducing meat)	If people eat less meat, global warming would be reduced	Even if I really liked meat, I would eat fewer meals with meat in them
Food (Reducing artificial fertilizers)	If farmers stopped using artificial fertilisers with nitrogen in them, global warming would be reduced	Even if it was more expensive, I would buy food grown without the use of artificial fertilisers
Indirect actions		
Environmental legislation	If politicians made the right kind of new laws, global warming would be reduced	I would vote for a politician who said they would bring in laws to reduce global warming, even though it would stop me doing some of the things I enjoy
Environmental taxation	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 increase taxes to pay for reducing global warming, even though it meant me having less money to spend
Environmental education	If people were taught more about it, global warming would be reduced	I would like to learn more about global warming, even though it would mean extra work for me
Environmental International cooperation	If there could be more agreement between different countries about not putting certain gases into the air, global warming would be reduced	Even though it might mean some inconvenience to me (like changing my job), I would vote for a politician who said they would sign agreements with other countries on global warming

The items of the questionnaire are displayed so that the 'pairing' of the items can be seen. In the actual questionnaire, the items were in random order, and paired items were in different orders in the two main sections.

Figure 2 Wording and available responses for the final four items of questionnaire

Items	Available responses
How worried are you about what Global Warming might do to the environment?	I am very worried I am quite worried I am a little bit worried I am not worried at all
How much do you think you know about Global Warming?	I know a lot about global warming I know something about global warming I know a little about global warming I know almost nothing about global warming
How 'environmentally friendly' do you think you are? (How much do you think you 'take care of' the environment by the things you do?)	I am very environmentally friendly I am quite environmentally friendly I am a bit environmentally friendly I am not at all environmentally friendly
Do you think that Global Warming is really happening now?	I am sure global warming is happening I think global warming is happening I don't know whether global warming is happening or not I am think global warming is not happening I am sure global warming is not happening

Figure 3 Wording of the permissible responses to the two sets of items.

Believed Usefulness of Action If I thought an action would help global warming by…	Score	*Degree of Willingness to Act* then I would…	Score
by quite a lot	1.00	definitely do it	1.00
by a fair amount	0.75	almost certainly do it	0.75
by a small but useful amount	0.50	probably do it	0.50
by a very small amount - hardly noticeable	0.25	perhaps do it	0.25
by nothing at all really	0.00	probably not do it	0.00

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The wording of the permissible responses is displayed 'matched'. This 'matching' suggests the minimum action ('then I would') that might reasonably be expected for a given belief about the usefulness of that action. The figures show the scores assigned to the different responses; these enabled various coefficients to be constructed.

Figure 4 Annotated graph to show relationship between the *Degree of Willingness to Act* and the *Believed Usefulness of Action*

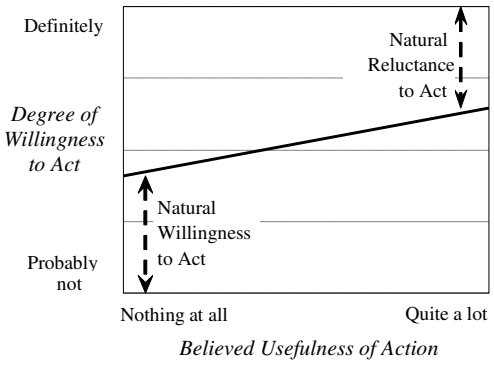
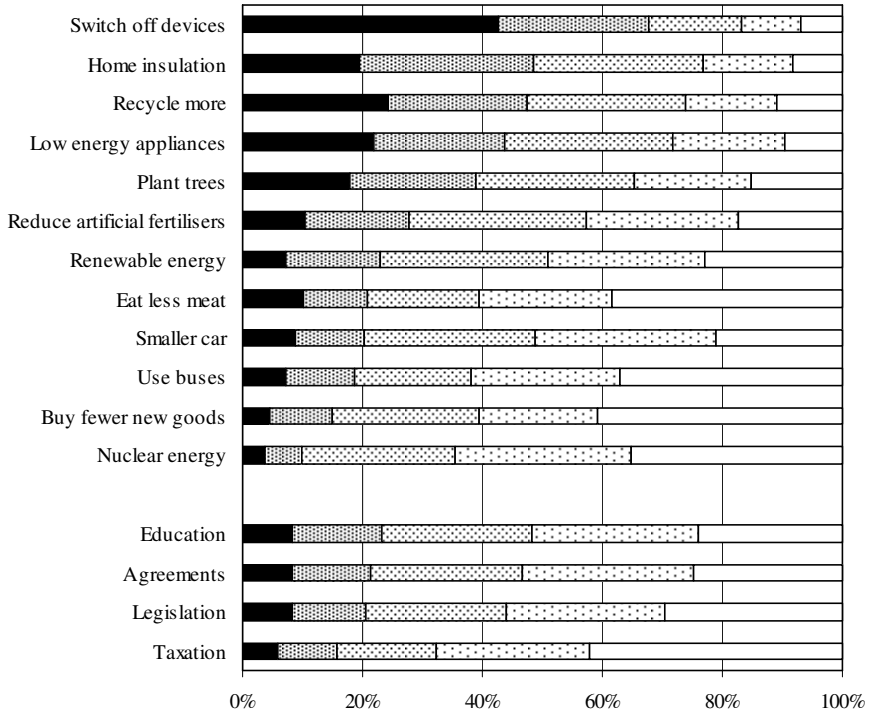


Figure 5 Secondary Students' willingness to undertake various pro-environmental actions, their beliefs about the usefulness of such actions and the relationships between these two measurements.

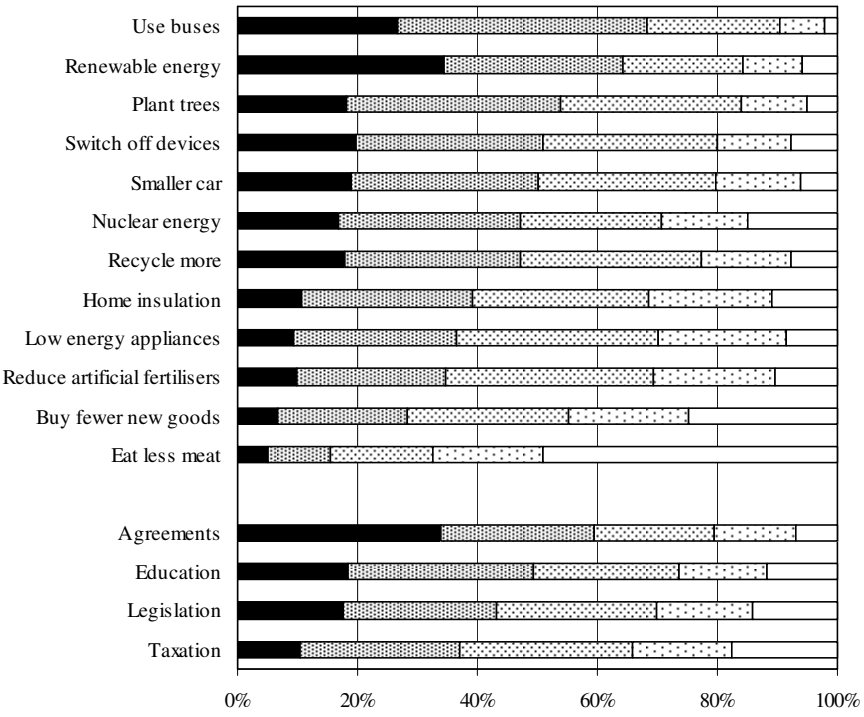
	Degree of Willingness to Act	*Believed Usefulness of Action*	*Potential Effectiveness of Education*	*Natural Willingness to Act*	*Natural Reluctance to Act*	*Potential Usefulness of Education*
	(% 'definitely' + 'almost certainly')	(% 'quite a lot' + 'a fair amount')	(Slope of *Degree of Willingness to Act* plotted vv *Believed Usefulness of Action*)	(Intercept when *Believed Usefulness of Action* is at minimum)	(Measurement between unity and the intercept when *Believed Usefulness of Action* is at maximum)	(*Potential Effectiveness of Education x* proportion of 'perhaps do it' and 'probably not do it')
Direct actions						
Smaller cars	20	50	0.17	0.29	0.54	0.09
Nuclear energy	10	47	0.15	0.20	0.64	0.10
Home insulation	49	39	0.25	0.46	0.28	0.06
Switch off unused devices	68	51	0.14	0.63	0.23	0.02
Plant trees	39	54	0.26	0.36	0.38	0.09
Recycle more	48	47	0.34	0.39	0.27	0.09
Reduce artificial fertilisers	28	35	0.27	0.31	0.42	0.12
Buy fewer new goods	15	28	0.15	0.23	0.62	0.09
Renewable energy	23	64	0.23	0.24	0.54	0.11
Use buses	19	68	0.18	0.19	0.63	0.11
Eat less meat	21	16	0.23	0.27	0.50	0.14
Low energy appliances	44	37	0.25	0.44	0.31	0.07
Indirect actions						
Legislation	21	43	0.23	0.24	0.54	0.13
Taxation	16	37	0.25	0.16	0.59	0.17
Agreements	21	59	0.24	0.23	0.54	0.13
Education	23	49	0.22	0.27	0.52	0.11

Figure 6 Secondary students' *Degree of Willingness to Act* to undertake different pro-environmental actions



For each action, the darkest bar, to the left hand side, represents the percentages of students who would 'definitely' undertake the action; the next, slightly lighter bar those who would 'almost certainly' undertake the action; the next, lighter bar, those who would 'probably' undertake the action; the next bar those who would 'perhaps' take the action; and the right hand, white bar, those who 'probably not' undertake the action. 'Direct' actions are in the upper section of the figure; 'indirect' actions are in the lower section. Within each section, actions are arranged in descending order of the combined percentages of students who would 'definitely' and 'almost certainly' take the action.

Figure 7 Secondary students' *Believed Usefulness of Action* of different pro-environmental actions



For each action, the darkest bar, to the left hand side, represents the percentages of students who responded that the action would reduce global warming by 'quite a lot'; the next, slightly lighter bar those who believe it would reduce global warming by 'a fair amount'; the next, lighter bar, those who believe it would reduce global warming by a 'small but useful amount'; the next bar those who believe it would reduce global warming by 'a very small, hardly noticeable, amount'; and the right hand, white bar, those who believe the action would reduce global warming by 'nothing at all'. 'Direct' actions are in the upper section of the figure; 'indirect' actions are in the lower section. Within each section, actions are arranged in descending order of the combined percentages of students who responded that the action would reduce global warming by 'quite a lot' and by 'a fair amount'.

Figure 8 Comparison of derived indices, *Natural Willingness to Act* and *Potential Effectiveness of Education* for two groups of students, those who are more or less concerned about global warming. The indices and categories are defined in the text.

	Natural Willingness to Act			*Potential Effectiveness of Education*		
Issue	More Concerned	Less Concerned	Sig	More Concerned	Less Concerned	Sig
Direct actions						
Smaller cars	**.40**	**.25**	**	.11	.12	
Nuclear energy	.22	.21		.18	.10	
Home insulation	**.54**	**.44**	*	.20	.23	
Switch off unused devices	**.75**	**.60**	**	.05	.09	
Plant trees	**.50**	**.30**	***	.18	.22	
Recycle more	**.51**	**.36**	**	.28	.28	
Reduce artificial fertilisers	**.41**	**.28**	**	.23	.20	
Buy fewer new goods	**.32**	**.19**	***	.10	.13	
Renewable energy	**.38**	**.18**	***	.14	.21	
Use buses	**.37**	**.15**	**	.07	.11	
Eat less meat	**.38**	**.20**	***	**.11**	**.28**	*
Low energy appliances	**.54**	**.41**	**	.18	.22	
Indirect actions						
Legislation	**.35**	**.21**	***	.20	.10	
Taxation	**.25**	**.13**	**	**.25**	**.11**	*
Agreements	**.32**	**.19**	**	.22	.16	
Education	**.42**	**.21**	***	.13	.15	

*** p<0.001 ** p<0.01 * p<0.05

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actions, this was because even those students with only a weak belief in the efficacy of

the action were prepared to do it anyway. For other actions,

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it was because even those students who believed that

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Differences between subsets of students

Differences between various groupings of students were explored in a number of ways. ANCOVA was used for the basic scores on the 32 items when looking at gender and year group together. For the derived indices, gradient and intercept were compared for any two groups using the standard technique of dummy variable creation and fitting a multiple linear regression model against the independent variable, the comparison variable (dichotomous) and the derived variable. Differences from any of these tests are noted below only if they are at the 0.05 level or better. When discussing these differences, percentages will be used for the main questions (defined as in the first two columns of Figure 5), whilst the derived indices will simply have their values compared (explained in the later columns of Figure 5).

Differences between male and female students

For three of the issues, more females than males were prepared to take action; thesesthese involved switching off unused electrical items (65%, 71%), reducing car use (15%, 23%) and eating less meat (15%, 27%). In terms of belief in the efficacy of actions, or

understanding, a further three issues showed that more females believed that once again had a greater sensitivity to: using energy-efficient domestic white goods (33%, 40%), reducing the purchase of new fashion items (26%, 31%), and taking into account a politician's willingness to legislate on the environment when voting (38%, 48%) would contribute to reducing global warming. Measures of the *Potential Effectiveness of Education*, showed only one difference between the sexes and that was for the question relating to international agreements (0.15, 0.33[1]), where it appears that females seem likely to be more influenced by education. On two issues there was a difference in the *Natural Willingness to Act*; for eating less meat females showed a greater natural willingness (0.22, 0.31), in line with the overall measurement for the question, but they seemed less naturally willing to vote in accordance with politicians views on international agreements (0.29, 0.15).

Differences between students in different year groups

In the descriptions below, the figures given are those for students in Year 7, 8, 9, 10 and 11. Differences between students in different year groups are reported below only if ANCOVA revealed statistically significant differences giving a trend across the year groups. By these criteria there were no significant and consistent trends across the year groups for students *Degree of Willingness to Act*. There were a number of differences, however, for students' *Believed Usefulness of Action*. For the most part, the level of students' *Believed Usefulness of Action* decreased over the year groups. So, fewer of the older students believed that adopting the use of smaller cars (57%, 55%, 52%, 51%, 33%), insulating homes (44%, 45%, 42%, 39%, 21%), switching off un-used electrical

[1] The *Potential Effectiveness of Education* is a ratio and therefore does not have units

items (61%, 57%, 48%, 48%, 39%), recycling more (54%, 60%, 47%, 37%, 33%), reducing the use of artificial fertilisers (35%, 46%, 37%, 29%, 22%), buying fewer fashion items (35%, 33%, 27%, 25%, 21%), reducing car use (76%, 70%, 65%, 71%, 58%), eating less meat (19%, 21%, 16%, 8%, 10%), using energy-efficient domestic appliances (47%, 42%, 31, 39%, 25%) would reduce global warming either by 'quite a lot' or by 'a fair amount'. Confidence in the effectiveness of the indirect actions also declined over the year groups. Thus, fewer of the older students thought that voting in accordance with promises on environmental legislation (53%, 46%, 38%, 45%, 36%) and taxation (47%, 38%, 34%, 38%, 27%), and international agreements (72%, 60%, 55%, 60%, 51%) could help to reduce global warming.

There were statistically significant increases in the *Potential Effectiveness of Education* across the year groups for the actions of planting trees (0.19, 0.16, 0.21, 0.28, 0.50) and increasing adoption of renewable energy (0.16, 0.23, 0.09, 0.24, 0.38), suggesting perhaps that persuading older school students of the effectiveness of these *specific* actions might be more effective in terms of behaviour change than teaching younger students. This trend was also evident in two of the indirect actions, related to supporting international agreements (0.16, 0.20, 0.11, 0.19, 0.43) and being prepared to undertakinge more environmental education (0.19, 0.10, 0.18, 0.25, 0.36). However, it was also noticed that for these, and only these issues, the *Natural Willingness to Act* started high and decreased across the year groups, as the *Potential Effectiveness of Education* increased. The conclusion would seem to be that adolescents' beliefs retain a degree of fluidity about these issues, withthat younger students are being less discriminatory, and

havinge a high willingness to act regardless of their understanding belief in the efficacy of the actionof the issue. This perhaps suggests that the teaching of these issues might be best targeted at older students. Firstly, oOlder students are more able to process the information with which which they are presentedhave, or which they believe. Secondly, because the Natural Willingness to Act declined across the grades, there may be potential for increasing their preparedness to act by convincing them of the effectiveness of these *specific* actions.and with these issues show a response in their intended actions which is more in line with their understanding. This perhaps suggests that the teaching of these issues might be best targeted at older students.

Differences between more and less concerned students

Finally, the relationship between the extent of students' concern and their willingness to act in various pro-environmental manners was investigated. Students were grouped according to their responses to a question in the final section of the questionnaire about how worried they are about global warming. Those who indicated that they were 'very' or 'quite' worried were considered to be 'more concerned' (n=452); those who responded that they were 'a little bit worried' or 'not worried at all' were considered to be 'less concerned' (n=460).

When the derived indices were compared for these two groups of students, it became apparent that the values for the *Natural Willingness to Act* indices were consistently higher for the more concerned students than for the less concerned students for all actions other than the increased adoption of nuclear power. In contrast, only two of the values of

Potential Effectiveness of Education showed statistically significant differences between the two groups, and these differences were relatively small. The details can be seen in Figure 8. It seems clear that, regardless of the degree of worry about global warming, the sense in which action might be influenced by understanding or belief is fairly stable, though different for each issue. On the other hand, the *Natural Willingness to Act*, the likely action even when it is believed to be ineffective, is significantly greater for almost all issues for those who are more concerned about global warming. Interestingly, the biggest differences are for the use of smaller cars (0.40, 0.25) and for the use of public transport instead of cars (0.37, 0.15). These issues seem to be little affected by education (the *Potential Effectiveness of Education* is small whether students are worried or not, varying between 0.07 and 0.12) and, as noted above, these are demanding behaviour changes that affect people's personal freedom and status. Worry about global warming, on the other hand, does seem to have some impact on action in this area. It has been suggested by research on air pollution (Boyes, Stanisstreet, Myers, Skamp & Yeung, 2007) that fear or worry, especially for western students, has a considerable influence on their stated willingness to take certain actions. In this case it would seem to be regardless of what students believe about the effectiveness of that action. Thus it would appear that the worry about global warming and its consequences might precipitate action, even if that action is thought unlikely to be helpful: a kind of insurance policy.

The one exception from Figure 8 is for the idea of being willing to pay more for electricity if it were produced by nuclear power. The *Natural Willingness to Act* in this

way is small (around 0.2) and the same for both groups of students. Clearly there are other concerns which, in the case of nuclear power, take precedencet.

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Environmental education for behaviour change: which actions should be targeted?

ABSTRACT

One aim of environmental education is to enable people to make informed decisions about their environmental behaviour; this is particularly significant with environmental problems that are believed to be both major and imminent, such as climate change resulting from global warming. Previous research suggests that there is no strong link between a person's general environmental attitudes and knowledge, and their willingness to undertake pro-environmental actions, so this study focuses on some *specific* issues. Using survey methods to produce quantitative data about students' beliefs concerning the usefulness of specific actions and their willingness to adopt them, novel indices have been constructed that indicate the potential of education to increase students' willingness to undertake those actions. The findings imply that altering a student's belief about certain issues will have little effect on their willingness to act. This can be because most students, even those with only a weak belief in the efficacy, are prepared to take action anyway. Conversely, it can be because a majority, including those convinced about the efficacy, is not prepared to take action. Education about such actions, where there is only a weak link between believed effectiveness and willingness to act, may be ineffective in terms of changing practice, because other factors such as social norms and situational influences dominate. For such actions other strategies may be required. For another set of actions, however, the benefits of education in changing practice seemed more positive; increasing recycling, reducing the use of artificial fertilisers and planting more trees are examples.

INTRODUCTION

"The literature on public understanding of climate change indicates widespread awareness of the issue and a general concern, but limited behavioural response"
(Lorenzoni, Nicholson-Cole & Whitmarsh, 2007)

Twenty years ago the scientific evidence for 'global warming' [1] was considered by some to be contentious (Stevenson, 1987; Boyes & Stanisstreet, 1993). Today, however, the weight of objective evidence has persuaded the majority of authoritative sources that the increase in global warming is a real phenomenon, caused by human-sourced greenhouse gases (IPCC, 1997), and that this is an increasing threat to the world's environmental integrity, social well-being (IPCC, 2001; 2007), economic stability (Stern, 2007) and political security (Solana, 2008). In view of these persuasive predictions, it is increasingly important to design and apply effective measures for reducing the emission of greenhouse gases, the primary drivers of global warming. In part, this will depend on central government policies. The UK government, amongst others, set ambitious targets to reduce by 12.5% (relative to 1990 levels) the levels of the major greenhouse gases by 2010, with a reduction by 20% for carbon dioxide in particular. Furthermore, the political goal is to reduce carbon dioxide by 60% by 2050 (DTI, 2003). Unfortunately, since these targets were set it has become apparent that the 20% reduction in carbon dioxide will not be achieved, throwing doubt on the attainability of the 2050 target of a 60% reduction (DEFRA, 2006).

In a complementary manner, it is estimated that about half of UK energy is used directly by individuals, for domestic use and personal transport. In these sectors, however, energy consumption is increasing (DEFRA, 2008a). What is needed, then, are mechanisms to persuade individuals to reduce their carbon contribution by limiting their energy use, because many individual-level actions can accumulate to produce environmentally significant impacts (Jensen and Schnack, 2006). Although there is disagreement about whether environmental education should

[1] In reality, the addition of anthropogenic pollutants to the atmosphere results in an exacerbation of the natural 'greenhouse effect' leading to 'global warming', the major effect of which is an alteration in the world's climate – 'climate change'. In this paper we have elected to use the term 'global warming' because it describes the primary consequence of this process.

encourage pro-environmental action or whether it should focus solely on knowledge and attitudes (Heimlich & Ardoin, 2008), it could be argued that, in view of the urgent call to reduce global warming, one of the aims of environmental education should be to engender in learners a preparedness to act in more environmentally sustainable ways (Mentzer & McEwen, 1999; Jurin & Fortner, 2002). Early models for encouraging environmental behaviour became known as 'information deficit' models (Burgess, Harrison & Filius, 1998). These were based on the assumption that if people understood more about the environment and the actions that would cause, or avoid, environmental degradation, they would behave in a rational manner and adopt environmentally sympathetic practices. In other words, it was believed that there was a relatively direct and positive relationship between a person's cognitive base about environmental problems and his or her willingness to act in such a way as to reduce these problems. Other models suggested a less direct link, in which action is influenced by both an intention to act and situational factors (Hines, Hungerford and Tomera, 1986-7). Some studies have shown that knowledge and behaviour are indeed related (Yencken, 2000). In many other cases, however, it seems that the relationship between knowledge and action is not robust (Rajecki, 1982; Hungerford & Volk, 1990; Posch, 1993), and it is acknowledged that there is what has come to be known as a 'gap' between cognition and action (Kollmus & Agyeman, 2002). In part, this 'gap' is due to the fact that behaviour is influenced by a plethora of other factors, not just knowledge; other beliefs, social pressures, physical facilitators and inhibitors can synergistically influence whether or not a particular action is pursued (Corraliza & Berenguer, 2000). Similarly, descriptive and injunctive social norms, standards by which actions are perceived as normally being undertaken, or as being approved or disapproved of, can influence whether or not a person acts in an environmentally sympathetic fashion (Cialdini, Reno & Kallgren, 1990). Perhaps most relevant to the present study is the finding that situational influences such as a person's belief in their own self-efficacy also partly determine the extent to which he or she acts in a pro-environmental manner (Devine-Wright, Devine-Wright & Flemming, 2004; Laskova, 2007). Despite these complications, many of these other factors are

themselves influenced by the cognitive base of the individual concerned, and thus potentially affected by education.

A further issue that has emerged as researchers have attempted to generate models of the incentives and disincentives to pro-environmental behaviour is that there are limitations in studying links between *general* environmental attitudes and potential behaviour patterns (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Dietz, Stern & Guagnano, 1998; Stern, 1992). Given this complexity, and a pressing need for a reduction in the emission of anthropogenic greenhouse gases, we have attempted to explore the role that education about the usefulness of *specific* pro-environmental actions might play in eliciting changes in the practices of individuals. We have designed an instrument that questions respondents about their willingness to undertake *specific* pro-environmental behaviours and, separately, their beliefs about the possible benefits of these particular behaviours in the context of one environmental problem - global warming. Three research questions have been addressed. Firstly, the degrees to which students report being willing to undertake a variety of specific pro-environmental actions have been ascertained. Secondly, the extents to which students believe these particular actions would be effective in reducing global warming have been investigated. Thirdly, the relationship between these two parameters, students' reported willingness to undertake specific actions and their beliefs about the usefulness of the same actions, has been explored. In addition, measures were sought of students' degree of concern about global warming, and the extent to which they thought that it was a real phenomenon. The overall aim was to determine the extent to which increasing students' understanding about the efficacy of specific actions might persuade individuals to increase their willingness to undertake those actions, so that education for changes in practice might be targeted for greatest efficacy.

METHODS

This study employed a novel questionnaire to probe the views of secondary students. The study was initiated in the UK, but has since been extended to Australia, the USA and a number of countries in mainland Europe; here we report the findings of the UK study.

Design of the questionnaire

Throughout the questionnaire, the term 'global warming' was employed, although in the instructions to students the term 'climate change' was included in parentheses. In individual items, however, the term 'global warming' alone was used because it was felt to be most closely linked to the primary cause of this environmental problem, and the focus of this study was to explore students' willingness to undertake actions which might contribute to potential solutions.

The questionnaire consisted of a coversheet, two main sections and a short final section. The coversheet asked respondents to record their grade and gender. Each of the two main sections of the questionnaire contained 20 items, 16 of which were about actions that would contribute to the amelioration of global warming, and four of which were distracters that were more idiosyncratic in nature. The latter were derived from ideas that had been raised by students themselves in earlier research (Boyes & Stanisstreet, 1993), and were included so that respondents would not feel obliged to respond positively to all questions (Oppenheim, 1992; Parmenter and Wardle, 2000). The results from these four items will not be considered in this paper. The other 16 actions were selected to provide a reasonably comprehensive coverage of the things that could, to varying degrees, reduce global warming. Most of the ideas in these items 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 concerned indirect actions, such as supporting increased environmental taxation or legislation. The section at the end of the questionnaire contained items designed to probe the level of students' concern about global warming, the extent of their perceived knowledge about global warming, the degree to which they considered

themselves to be environmentally 'friendly', and whether or not they believed that global warming was a real phenomenon that was already happening. These questions, and the available responses, are shown in Figure 1.

We now consider the two main sections of the questionnaire. The focus of the first of these was the degree to which students would be willing to undertake a particular action, in the words of the coversheet of the questionnaire, "for the sake of the environment and the future of the Earth"; no mention was made of global warming at this stage. Each item took the form of a conditional clause indicating the personal cost or inconvenience of the action, followed by a simplified description of the action. The wording of the items can be seen in the right hand column of Figure 2, and the available responses to these items, which ranged from "I would definitely do it" to "I would probably not do it", and the ways in which they were scored, are shown in the right side of Figure 3. The scored responses produced by the items in this section of the questionnaire were designated students' *Degree of Willingness to Act*.

The items in the second main section of the questionnaire concerned the same pro-environmental actions as those in the first main section, although the order was different so that the pairing of the questions was not immediately apparent to the respondents. Here, however, the focus of the questioning was on the extent to which respondents believed that the actions were useful in alleviating global warming. The wording of these items can be seen in the left column of Figure 2, and the available responses, which ranged from "quite a lot" to "nothing at all really", and the ways in which they were scored, are shown in the left side of Figure 3. The scored responses were designated students' *Believed Usefulness of Action*.

Figure 2 also illustrates the pairing of the items and the themes within the questionnaire. In addition to the items being paired, the available responses in the two main sections of the

questionnaire were designed to 'match', in semantic terms. Figure 3 illustrates this, where the two response scales are shown in apposition. If, for example, a student believed that a particular action would help by 'quite a lot', this was matched in the other section of the questionnaire to the response that they would 'definitely' be willing to do it; each of these responses received a score of 1. Conversely, if a student believed that an action would reduce global warming 'by nothing at all', this is matched to the action section response that they would 'probably not' do it, and both responses received a score of zero. The intermediate responses were also designed to correspond in a similar way, semantically and by score.

The final wording of the paired questionnaire items and matched response scales came about from a series of discussions with a group of researchers and teachers. The questionnaire was trialled with 134 students (age 14 years), and the only modification entailed the removal of the word 'insulation' and the rephrasing of the pair of questions concerned.

Construction of the indices

From the responses to the two main sections of the questionnaire, the *Degree of Willingness to Act* and *Believed Usefulness of Action*, a number of derived indices were produced that have been used to explore the connections between them. Although the two response scales are ordinal and although they measure different things, it was felt that because of their semantic matching (Figure 3), some mathematical manipulation of the data is acceptable; this is explored below.

Potential Effectiveness of Education

The indices we wish to focus on here relate to the extent to which increasing the understanding about the efficacy of a particular action through specific environmental education might persuade individuals within a cohort to undertake that action. To obtain these for a particular action, student measures of the *Degree of Willingness to Act* were plotted against their value of the *Believed*

Usefulness of Action, and the trend line was fitted. This produced a graph of the type exemplified in Figure 4. The semantic matching of the responses means that linear regression is less sensitive to the errors involved in using ordinal scales. The slope of such a trend line indicates the extent to which the willingness of students to undertake an action might be said to be dependent upon their belief in the usefulness of that action. The gradient, therefore, provides a measure of the extent to which willingness to undertake an action might be increased by persuading students of the environmental effectiveness of that action; we have called this gradient, in the present context, the *Potential Effectiveness of Education*. Once the gradient of the line has been determined for a pair of questions, two other derived indices can be calculated from the intercepts. The intercept when the *Believed Usefulness of Action* is zero represents the likely action of those students who believed that such an action would be ineffective in reducing global warming; we term this the *Natural Willingness to Act,* and Figure 4 is annotated to show this. In a complementary fashion, the distance marked *Natural Reluctance to Act* in Figure 4 is a measure of the extent to which students will not take action, even though the *Believed Usefulness of Action* is at its maximum. These three indices may be useful in comparing the potential effect of education about different specific pro-environmental actions in terms of changing practice.

Comparing the values of the *Potential Effectiveness of Education* for different actions gives an indication of those actions for which education about their usefulness might lead to an increased willingness to act, and other actions where education will probably be less effective in this role. On a population basis, however, there is another measurement that will influence the efficacy of education to this end, namely the proportion of the population who are not already reporting an intention to take action. Thus, education might be most productive in terms of changing practices if directed at those actions that relatively few of the population are already willing to undertake. A final index was therefore calculated, the *Potential Usefulness of Education*, by multiplying the

Potential Effectiveness of Education by the proportion of students in who would 'probably not' or only 'perhaps' undertake the action.

RESULTS

In all, 961 students in Grades 6 (11-12 years old) to 10 (15-16 years old) (UK National Curriculum Year Groups 7 through 11) from four state Community Comprehensive schools in the North West of England completed the questionnaire. Of this sample, 18% were in Grade 6, 23% were in Grade 7, 25% were in Grade 8, 17% were in Grade 9, and 17% were in Grade 10. Males comprised 52% of the cohort, females 48%; males and females were evenly distributed over the years. The responses to the final four questions provided some background information about the beliefs and views of the students. Some 61% of the students thought or were sure that global warming was happening, with half of this figure (31%) being sure of this. About half of the students expressed concern about global warming, with 16% reporting being 'very worried' and a further 33% reporting being 'quite worried'. Few students, about 14%, thought that they were well informed (knew 'a lot') about global warming, although a further 39% considered they knew 'something' about it. Nearly half of the cohort (45%) thought of themselves as being either 'very' or at least 'quite' environmentally friendly. Thus, many of this group of students believed that global warming is a real phenomenon, few thought that they were especially well informed about it, and about half were concerned about its consequences.

In the descriptions that follow, overall results for the complete cohort are reported first. Following this, statistically significant differences between the responses of male and female students and between students of different grades are described.

Students' *Degree of Willingness to Act*

The findings concerning students' *Degree of Willingness to Act* for different pro-environmental actions are given in the first column of Figure 5 and illustrated graphically in Figure 6. In Figure 6, the items are arranged in descending order according to the combined percentages of students who would 'definitely' or 'almost certainly' undertake the action; in the descriptions below, these same percentages are reported. The direct action to which most students were amenable (68%) was to switch off un-used electrical appliances. The prospect of installing home insulation was acceptable to about half of the students (49%), as were the ideas of recycling materials (48%) and paying more for energy-efficient domestic appliances (44%). Over a third of the cohort (39%) were willing to pay for more tree-planting, although fewer (28%) would accept the increased price premium for food grown without artificial fertilisers, and even fewer (21%) would be prepared to reduce their consumption of meat. In terms of personal transport, only about a fifth of the students (20%) would consider getting a smaller car and a similar proportion (19%) would accept reducing car use by using public rather than private transport. Rather few of the students (15%) would accept buying fewer fashion items. In terms of energy production, very few students (10%) felt that using nuclear power was acceptable, perhaps because other environmental issues are associated with nuclear energy. In addition, and perhaps surprisingly, relatively few respondents (23%) would consider paying more for renewable energy sources. Most of the indirect actions were also unpopular. Only about a quarter of the students would be prepared to undertake more education about environmental issues (23%) or allow their vote to be influenced by support for new environmental legislation (21%), international agreements (21%) and, for even fewer, increased environmental taxation (16%). Thus, students appeared willing to undertake different environmental behaviours to varying extents. There was a strong association between most of the 16 *Degree of Willingness to Act* items and the question in the third section of the questionnaire about the extent to which students were worried about global warming; this will be discussed later.

Students' *Believed Usefulness of Action*

Items in the second main section of the questionnaire explored students' beliefs about the usefulness of the various actions in reducing global warming, their *Believed Usefulness of Action*, and the data from the responses are given in the second column of Figure 5 and illustrated graphically in Figure 7. In Figure 7, the items are arranged in descending order according to the combined percentages of students who thought that the action would reduce global warming by 'quite a lot' or by 'a fair amount'. In the descriptions that follow, these same percentages are reported. Students apparently made a link between global warming and personal transport; two actions thought by many of the students to contribute to a reduction in global warming were to reduce car use (68%) and drive smaller cars (50%). Energy production also seemed to be linked with global warming in students' minds, since many believed that production of energy from renewable sources (64%) and from nuclear sources (47%) could play a role in reducing global warming. Perhaps linked to this, another relatively popular idea was energy conservation by switching off unused electrical items (51%). Surprisingly, rather fewer students realised that installing home insulation (39%) or the use of energy-efficient domestic appliances (37%) could reduce global warming. Tree planting was also thought to contribute to decreasing global warming by more than half of the students (54%), and almost as many (47%) appreciated the role that increased recycling could play. Rather fewer of the students (35%) realised that reducing the use of artificial fertilisers and decreasing meat consumption (16%) could lessen global warming, perhaps because the mechanisms involved gases other than carbon dioxide, the latter being perhaps the most well-known greenhouse gas. Relatively few students (28%) realised that buying fewer new items could help to reduce global warming; this may be because fewer students appreciated the carbon cost of manufacturing and distributing new consumer goods. Of what we have termed the 'indirect actions', those related to international agreements were thought to be the most effective (59%), with education (49%), legislation (43%) and taxation (37%) being thought less so. Thus, students believed that the various environmentally-friendly actions that had been suggested in the questionnaire would be differentially effective in reducing global warming.

Relationship between the *Degree of Willingness to Act* and *Believed Usefulness of Action*

As explained above, a number of indices can be obtained from the responses to the two main sections of the questionnaire, where the scored items were called the *Degree of Willingness to Act* and the *Believed Usefulness of Action*. Some of these will now be discussed.

The *Potential Effectiveness of Education* provides an indication of the extent to which increasing understanding about particular actions through specific environmental education might persuade individuals to undertake those actions. This relationship was quantified by linear regression, and the results are illustrated schematically in Figure 4; the values of the indices from the regression are summarised in the last four columns of Figure 5. The first of these, the slope of the regression line constructed when the *Degree of Willingness to Act* and the *Believed Usefulness of Action* for pairs of actions are plotted, has been designated the *Potential Effectiveness of Education*; a high value of this index represents a steep relationship between the extent to which students believe an action to be effective and their willingness to undertake that action. In such cases, persuading students of the efficacy of the action should result in more students purporting to take that action. Where the relationship is shallower, indicated by a lower value of the *Potential Effectiveness of Education*, education about the action is less likely to result in more students from this cohort adopting it. The other two indices, the two vertical dimensions marked in Figure 4, provide indicators of the extent to which students will undertake the action anyway, without believing in its effectiveness (*Natural Willingness to Act*), and of the extent to which students will avoid the action even if they believe it is highly effective (*Natural Reluctance to Act*); they each take a value between zero and one.

Figure 5 shows that for some actions the value of the slope of the line, the *Potential Effectiveness of Education*, was low, suggesting that there was little change in the willingness to undertake an action for different beliefs in the effectiveness of that action. For example, this was true for the action of

switching off unused electrical items (0.14). In this case, the slope of the line was shallow because the *Natural Willingness to Act* was relatively high (0.63); students were prepared to take this action in any case. Here, it is likely that other motivators, such as parental exhortations to reduce electricity bills, coupled with a relatively low level of inconvenience, meant that students would be taking this action anyway. The value of the *Potential Effectiveness of Education* was also fairly low for some other actions such as adopting more nuclear power (0.15), reducing car use (0.18), avoiding buying new fashion items (0.15) or purchasing smaller cars (0.17). In these cases, however, the slope of the line was shallow because the *Natural Reluctance to Act* tended to be quite high; even if students believed these actions to be effective in reducing global warming, they seemed unwilling to undertake them. For issues such as these it is probable that other disincentives, such as major inconvenience, substantial changes in lifestyle or environmental and health concerns, would prevent students taking these actions. In yet other cases there was a steeper association between a belief in the effectiveness of an action and a willingness to undertake it. Increasing the amount of material that is recycled (0.34), reducing the use of artificial fertilisers (0.27) and tree planting fell into this category (0.26). For these, the *Natural Willingness to Act* and the *Natural Reluctance to Act* were both relatively low, and so the slope of the line was fairly steep. For these specific actions, then, although many other factors impinge upon behaviour, the data indicate that educating students about the effectiveness of the action might well result in more of the students adopting the action. In summary, there are some pro-environmental actions that will probably not be induced by convincing students of their efficacy, and there are others that probably will.

There is another factor that will impinge upon the degree to which environmental education might be effective on a population level. In terms of behaviour change, the overall effectiveness of such education will be maximised when directed at those actions that a high proportion of the population are not already undertaking. In an attempt to give some quantitative comparison to the various actions raised in the questionnaire, a final index, the *Potential Usefulness of Education,* was

constructed by multiplying the *Potential Effectiveness of Education* by the proportion of students who would 'probably not' or only 'perhaps' undertake the action; these data are shown in the final column of Figure 5. This multiplication produces much smaller numbers, but the bigger of these indicate that teaching about the effects of reducing meat consumption (0.14), lowering the use of artificial fertilisers (0.12), decreasing car use (0.11) and increasing the proportion of energy generated from renewable sources (0.11) should be useful areas on which to concentrate teaching.

Differences between subsets of students

Differences between various groupings of students were investigated in a number of ways. ANCOVA was used for the basic scores on the 32 items when exploring, simultaneously, differences between the responses of male and female students, and students in different grades. ANCOVA can be used not only to analyse the effect of several categorical independent variables on a dependent variable (ANOVA) but can include one or more continuous variables which may predict the dependent variable. In this case grade was used as a more or less continuous variable. For the derived indices, gradient and intercept were compared for any two groups using the standard technique of dummy variable creation and fitting a multiple linear regression model against the independent variable, the comparison variable (dichotomous) and the derived variable. Differences revealed by any of these tests are noted below. When discussing these differences, the percentage of the top two categories will be reported for the main questions (defined as in the first two columns of Figure 5), whereas the derived indices will simply have their values compared (explained in the later columns of Figure 5).

Differences between male and female students

In this section, the first figures in brackets will be those for the males, followed by those for the females. For the *Degree of Willingness to Act* items, more females than males were prepared to take action on some issues; this included switching off unused electrical items (65%, 71%, $p<0.05$),

reducing car use (15%, 23%, p<0.05) and eating less meat (15%, 27%, p<0.001). In the case of items to determine the *Believed Usefulness of Action*, three issues showed that females had a greater belief in using energy-efficient domestic white goods (33%, 40%, p<0.01), reducing the purchase of new fashion items (26%, 31%, p<0.05) and taking into account a politician's willingness to legislate on the environment when voting (38%, 48%, p<0.01).

Measures of the *Potential Effectiveness of Education*, showed only one difference between the genders and that was for the question relating to international agreements (0.15, 0.33, p<0.01), where females appeared more likely to have their behaviour influenced by their understanding or belief. For two issues there were significant differences in the *Natural Willingness to Act*; for eating less meat females showed a greater inherent compliance (0.22, 0.31, p<0.001), but they seemed less naturally willing to vote in accordance with politicians' views on international environmental agreements (0.29, 0.15, p<0.01).

Differences between students in different grades

Differences between students in different grades are reported below only if ANCOVA revealed statistically significant differences giving a trend across the grades. In the descriptions that follow, the percentage figures quoted are for the top two categories of response across Grades 6, 7, 8, 9 and 10. Within the 16 *Degree of Willingness to Act* items, there were 6 significant and reasonably consistent trends downwards across the grades. These were: switching off unwanted appliances (81%, 65%, 63%, 69%, 66%, p<0.01), purchasing foods cultivated without artificial fertilisers (34%, 35%, 18%, 30%, 24%, p<0.001), eating less meat (28%, 28%, 14%, 16%, 19%, p<0.001), buying more efficient appliances (56%, 46%, 36%, 45%, 40%, p<0.001) and voting for politicians in light of their policies on 'green' legislation (34%, 24%, 14%, 18%, 17%, p<0.001) and their support for international environmental agreements (36%, 21%, 15%, 20%, 18%, p<0.001).

In the other main section of the questionnaire, the *Believed Usefulness of Action*, there were also a number of differences that for the most part showed a decrease over the grades. So, fewer of the older students believed that global warming would be reduced (by 'quite a lot' or by 'a fair amount') by adopting the use of smaller cars (57%, 55%, 52%, 51%, 33%, $p<0.001$), insulating homes (44%, 45%, 42%, 39%, 21%, $p<0.001$), switching off un-used electrical items (61%, 57%, 48%, 48%, 39%, $p<0.001$), recycling more (54%, 60%, 47%, 37%, 33%, $p<0.001$), helping to reduce the use of artificial fertilisers (35%, 46%, 37%, 29%, 22%, $p<0.001$), buying fewer fashion items (35%, 33%, 27%, 25%, 21%, $p<0.001$), reducing car use (76%, 70%, 65%, 71%, 58%, $p<0.001$), eating less meat (19%, 21%, 16%, 8%, 10%, $p<0.001$) or using energy-efficient domestic appliances (47%, 42%, 31, 39%, 25%, $p<0.001$). Confidence in the effectiveness of most of the indirect actions also declined over the grades. Thus, fewer of the older students saw the benefit, with regard to global warming, of voting in accordance with promises on environmental legislation (53%, 46%, 38%, 45%, 36%, $p<0.01$) and taxation (47%, 38%, 34%, 38%, 27%, $p<0.001$), and international agreements (72%, 60%, 55%, 60%, 51%, $p<0.001$).

There were a number of differences across the grades in the *Potential Effectiveness of Education*, as tested using two groups of students (top two and bottom two grades) and the standard technique described earlier. Generally, the analysis showed increases in the *Potential Effectiveness of Education* across the grades; this included the actions of planting trees (0.19, 0.16, 0.21, 0.28, 0.50, $p<0.05$) and increasing adoption of renewable energy (0.16, 0.23, 0.09, 0.24, 0.38, $p<0.05$). Although it is known that the knowledge-behaviour link is weak (Kollmus & Agyeman, 2002), it would appear from these findings that it is stronger for the older students, and would suggest perhaps that teaching about the efficacy of these specific actions might be more effective with older school students than with their younger counterparts. This trend was also evident in two of the indirect actions, related to supporting international agreements (0.16, 0.20, 0.11, 0.19, 0.43, $p<0.05$) and being prepared to undergo more environmental education (0.19, 0.10, 0.18, 0.25, 0.36, $p<0.05$).

However, it was also noticed that for these, and only these issues, the *Natural Willingness to Act* started high and decreased across the grades, as the *Potential Effectiveness of Education* increased. The conclusion would seem to be that adolescents' views retain a degree of flexibility about these issues, with younger students being generally less discriminatory, and having a high willingness to act regardless of their belief in the efficacy of an action, whereas older students seem to show a response in their intended actions which is more in line with their understanding.

Differences between more and less concerned students

Finally, the relationship between the extent of students' concern about global warming and their willingness to act in various pro-environmental manners was investigated. Students were grouped according to their responses to a question in the final section of the questionnaire about how worried they are about global warming. Those who indicated that they were 'very' or 'quite' worried were considered to be 'more concerned' (n=452); those who responded that they were 'a little bit worried' or 'not worried at all' were considered to be 'less concerned' (n=460).

Rather than examine how these two groups responded to the *Degree of Willingness to Act* variables, which inevitably contain information about students with different degrees of *Believed Usefulness of Action*, we elected to focus on the extent to which being more or less worried might affect students' inherent willingness to take action, their *Natural Willingness to Act*. When the 16 regressions were performed for the two groups of students, and the indices compared using the dummy variable technique mentioned earlier, it became apparent that the values for the *Natural Willingness to Act* indices were consistently higher for the more concerned students than for those who were less concerned; this was true for all actions other than the increased adoption of nuclear power. Figure 8 shows the details for all the differences measured, where one may recall that the *Natural Willingness to Act* mapped on to a scale with five values, from zero ('probably not') to one ('almost certainly').

In contrast to these differences, only two of the values of *Potential Effectiveness of Education* showed statistically significant differences between the two groups, and these differences were relatively small. It seems clear from Figure 8 that, regardless of the degree of worry about global warming, the sense in which action might be influenced by understanding or belief is fairly stable (though different for each issue). On the other hand, the *Natural Willingness to Act*, the likely action even when it is believed to be ineffective, is significantly greater for almost all issues for those who are more concerned about global warming. Research on students' views about air pollution suggest that worry can have a considerable influence on the stated willingness to take certain environmental actions, particularly in some cultures (Boyes, Stanisstreet, Myers, Skamp & Yeung, 2007). The results of the present study further indicate that worry about global warming and its consequences is indeed likely to precipitate action, independent of whether or not it is thought to be helpful.

DISCUSSION

Research of this nature inevitably has some limitations. For example, the fact that we wished to encompass in this study a reasonably comprehensive range of actions that could, in reality, contribute to a reduction in global warming, inevitably led to a number of consequences. Firstly, this meant that some of these actions were out of the current locus of control of secondary students, who will assume the capacity to take them only later in life. For example, students in this age group will not be able to vote yet about environmental taxation or legislation, or be directly able to purchase energy-efficient consumer durables, although their views may have some influence on parental decisions. Furthermore, whether or not students are able to undertake a particular action may have some influence on their stated intention to take it. Secondly, the selected actions varied in terms of the directness of their link to a reduction in global warming. Use of smaller cars, for example, has a fairly obvious link to a reduction in carbon dioxide emission, whereas the link

between purchasing fewer consumer goods and reducing global warming is more circuitous and requires an awareness of the production of greenhouse gases in manufacture and distribution. Thirdly, some of the issues represented in the questionnaire, such as the extended use of nuclear power, have counter-balancing environmental arguments, whereas others do not. For all of the actions, one can argue that any response of an individual indicating that they intend to act will not necessarily mean that they will do so (Downing & Ballantyne, 2007), although it is unlikely that an individual who states an intention not to take an action will then take it. Finally, although gaining any absolute measure of attitudes or intentions is problematic (Reid, 2006), the instrument devised does enable attitudes and intentions to a series of pro-environmental actions to be compared.

Approximately two thirds of the students in this study believed that global warming is a real phenomenon, paralleling the high general awareness of global warming in the adult population (MORI, 2004). Furthermore, about half of the respondents expressed concern about the consequences of global warming, again similar to the adult population (PEW Research Centre, 2009), suggesting that consciousness of, and concern about, global warming are beginning to develop early. Perhaps because of anxiety about the issue, UK adults in general appear to support, in principle at least, both individual and political action to reduce global warming (BBC, 2007); about half of the UK population believe that modifying individuals' practices would be effective. In a complementary manner, a proportion of the adult population in general would support the introduction of further environmental legislation, partly because this is seen as fairer, but also because it means that pro-environmental behaviour does not rely only on an individuals' willingness to act (Darier & Schule, 1999).

In the context of these general attitudes, the findings of the present study indicate that among UK secondary students there is a differential willingness to undertake different pro-environmental actions - what we have termed the *Degree of Willingness to Act*. Among the more direct actions,

for example, many students report a willingness to switch off unused electrical items in the home, whereas far fewer are prepared to alter their practices concerning personal transport by using public rather than private transport, or by accepting the use of smaller, more energy-efficient private vehicles, unless they are particularly worried about global warming. The differential willingness to undertake diverse pro-environmental actions is similar to that reported for adults, who are more prepared to increase recycling or to take action to conserve energy in domestic situations, but less willing to modify their travel habits (Shackley, McLachlan & Gough, 2004; Kasemir *et al*, 2003; O'Connor, Bord & Fisher, 1999). Each of the pro-environmental actions raised in this study has associated incentives and disincentives for young people, the nature and extent of which will differ between different actions. These motivators and inhibitors stem from a plethora of sources, including beliefs, social pressures (Cialdini, Reno & Kallgren, 1990), social background (Pruneau *et al*, 2007), characteristics of the physical context (Corraliza & Berenguer, 2000) and a person's action competence (Jensen & Schnack, 2006).

This range of motivators and inhibitors means that the likelihood of undertaking any particular pro-environmental action is the result of an interaction between a general feeling of benefiting the environment, coupled with more concrete personal incentives, disincentives and concerns. Switching off un-used electrical items, for example, causes only minor inconvenience so carries few such inhibitors. In addition, it may carry an incentive in that it aligns with parental exhortations to 'save electricity' for financial reasons. Use of public transport, on the other hand, may be perceived as carrying a major inconvenience and could be associated with a negative social image amongst school students' peer groups, with social norms acting as a disincentive (Cialdini, Reno & Kallgren, 1990). For indirect actions such as the influencing of voting patterns, rather few of the students seemed willing to consider increased environmental taxation, legislation or education or, perhaps surprisingly, even international agreements. Whilst it is unclear what voting priorities young people may have, a part of their general unwillingness to consider such issues may be because there is a

tendency for them to distrust politicians (Smith, Stanisstreet & Boyes, 2005) and other authority figures (Stern, 2008). Such mistrust has major implications for a population that approves in principle of the introduction of pro-environmental actions by central government, but seems less willing to take this into account when voting.

The findings of the present study also indicate that students consider that different actions may have different levels of usefulness in reducing global warming, a measurement we termed the *Believed Usefulness of Action*. For example, reducing car use, generating electricity from renewable sources and switching off un-used electrical items were thought to contribute to reducing global warming. In addition, tree planting was seen as useful in this context. The prime effect of all of these actions relate to atmospheric carbon dioxide, either by decreasing carbon dioxide emissions or, in the case of tree planting, by increasing the rate of removal of carbon dioxide from the atmosphere. Decreasing the use of artificial fertilisers or reducing meat production was thought by students to be less effective. In these cases the greenhouse gases involved are nitrogen oxides and methane, respectively. It may be that the efficacy of such pro-environmental actions in terms of global warming may be less well appreciated because the contribution of these two gases to global warming is less well known than that of carbon dioxide (Boyes & Stanisstreet, 1993, 2001), the role of which has been more recently re-enforced by phrases such as 'carbon footprint', 'carbon dependency' and 'carbon trading'. Students were also not strongly aware of the link between consumption of new 'fashion' items and global warming, perhaps because the energy consumed in their manufacture and transport to the point of purchase does not come immediately to the minds of young people.

By combining the data obtained from the two main sections of the questionnaire, the *Degree of Willingness to Act* and the *Believed Usefulness of Action*, it was possible to derive a series of novel indices to gain insight into the probable advantage, in terms of changing students' practices, of

persuading young adults of the efficacy of different pro-environmental actions in ameliorating global warming. In particular, the *Potential Effectiveness of Education* is a measure, in the context of the present study, of the association between belief in the effectiveness of an action and the willingness to undertake it. Certain actions had rather low values for the *Potential Effectiveness of Education*, indicating that education might be less effective for such actions in terms of behaviour change. There are two reasons why the *Potential Effectiveness of Education* might be low. In some cases, such as switching off un-used electrical items, this was because students showed a high *Natural Willingness to Act* - they would perform such actions irrespective of a belief or not in their merit. In other cases a low *Potential Effectiveness of Education* was associated with a high *Natural Reluctance to Act.* Here, even a relatively strong belief in the efficacy of an action did not promote its uptake, presumably because there were other disincentives in place; the nature of such disincentives would, of course, vary between different actions. For example, adoption of nuclear power may show a high *Natural Reluctance to Act* because of fears about environmental or health impacts of nuclear power. Change in transport habits, such as the use of smaller cars or substitution of public for private transport, could be somewhat intractable because environmental sensitivity would be out-weighed in decision-making by preferences about lifestyle or personal convenience, an example of a physical inhibitor acting as a disincentive (Corraliza & Berenguiar, 2000). In addition, students were resistant to reducing their purchase of new 'fashion' items, perhaps because consumption of this sort is perceived as a natural characteristic of their life-style. In such cases, where the *Potential Effectiveness of Education* is low, education alone might be of only limited benefit in terms of altering students' behaviour, although it might be a useful component in a series of measures. For example, introduction of potentially unpopular environmental legislation might be made more acceptable if there is a general understanding of why it is necessary.

In the case of other pro-environmental actions, there was a stronger relationship between the extent to which an action was believed to be effective in reducing global warming and a willingness to

undertake it; in other words, the *Potential Effectiveness of Education* was higher. Increasing recycling, reducing the use of synthetic fertiliser, tree planting, installing home insulation and using energy-efficient domestic appliances were examples of these actions. The first of these might be especially relevant because this action is within the locus of control of individual young people. Indeed, it has been shown that in the case of health education (Wilcox *et al*, 1981: Croucher *et al*, 1985), young people may influence the practices of the family in which they live, even though the effect may be weak.

With virtually all of the issues, the rate at which intended action increased with belief about that action did not depend on how worried the students were about global warming. On the other hand, the extent to which the more worried students were prepared to take action even when they did not believe it to be effective, was considerably greater; that is, the *Natural Willingness to Act* was greater in the more concerned individuals. One possible explanation is that the more concerned students make an assessment that, even though they perceive the action as having little or no effect, it is worth taking 'just in case', because they worry about the outcome of inaction being so devastating. An alternative explanation is that the willingness to take action and the concern about the consequences of global warming may each be a reflection of a 'constellation' of underlying attitudes (Heimlich & Ardoin, 2008), which includes students' perception of themselves as being pro-environmental; almost half of the students in the present study declared themselves to be 'environmentally friendly'. The one issue for which there was no difference between the declared intentions of worried and unconcerned students was the idea of being willing to pay more for electricity if it were produced by nuclear power. Perhaps, in the minds even of those students who are concerned about global warming, the risks associated with the proliferation of nuclear energy are more significant than the consequences of global warming.

In terms of persuading people to alter their behaviour, not all of those who are at present unwilling to undertake actions will be amenable to changing their practices. The adult population can be considered to consist of various groups with different characteristic behaviours and attitudes (DEFRA, 2008b). Furthermore, research in the USA has suggested that society may be considered to consist of six 'segments', from the 'Alarmed' who are sure that global warming is happening and are worried about it, to the 'Dismissive' who consider that global warming is not happening and so regard changes in behaviour as unnecessary (Maibach, Roser-Renouf & Leiserowitz, 2009). Members of some of these segments are more amenable to change than others. A further index, the *Potential Usefulness of Education*, attempted to take account of the size of the potential education audience, that is, the proportion of students who did not already intend to undertake such actions. Actions with a high *Potential Usefulness of Education* were those for which intended behaviour appeared to be strongly influenced by a belief in their effectiveness (that is, the *Potential Effectiveness of Education* was high), and which a relatively high proportion of students are at present unwilling to undertake. Using this index, certain specific actions emerge as useful targets for education; a reduction in meat consumption (and therefore production) and a willingness to pay more for produce grown without the use of artificial fertilisers, together with a decrease in car use and production of energy from renewable sources were such actions. Thus, the *Potential Usefulness of Education* enables us to target actions which are not at present accepted by a large proportion of the population. In a complementary manner, however, continuing environmental education directed towards those who are already prepared to take action is also necessary in order to reinforce and maintain their existing pro-environmental behaviour, particularly when this has been engendered through social marketing (Heimlich & Ardoin, 2008).

The present study reveals that for different actions there is a different degree of association between a belief in the efficacy of an action and a willingness to undertake it; this variation is one reason why environmental education in *general* might be less than fully effective in terms of behaviour

change. Even in the case of specific actions, it is apparent that for some actions education to persuade learners of their usefulness in terms of a major environmental problem has little potential on its own to be effective in terms of modifying young people's practices.

Our research suggests that where there were differences between the responses of male and female students, females tended to be more sensitive to the benefits of certain pro-environmental actions, and more willing to undertake other pro-environmental actions. This is congruent with the observation that females tend to score more highly than males on instruments that measure of environmental attitudes (Burger *et al*, 1998; Taskin, 2009). The results also indicate that the degree of association between belief in the effectiveness of an action and a willingness to undertake it differs across different age groups of students. It appears, in contrast to our intuition, that older secondary students might respond more to teaching than their younger counterparts in terms of behaviour change. Perhaps a potential hazard, then, of initiating education about pro-environmental actions too early might be that of over-exposure; the possibility is that by the time that students reach their most receptive stage they may be in a state of environmental 'fatigue', in the same way that donors to charity are thought, eventually, to suffer 'compassion fatigue' (Gallup, 2009; Ker, 2009). In addition to the heterogeneity that could be linked to overt factors such as gender and year group, it appears that there is also an association between the level of concern among students about global warming, and their willingness to undertake pro-environmental actions. Education strategists and practitioners should be aware, therefore, of this further heterogeneity within the student population; like adults (Lorenzini, Nicholson-Cole & Whitmarsh, 2007; DEFRA, 2008b), students will not be uniform in their behavioural responsiveness to environmental education even about specific actions.

The discrepancies between belief and willingness to act for different actions revealed in this study originate in the variety of other, sometimes non-environmental, incentives and disincentives

associated with the various actions. It would be interesting, in further research, to investigate the detail of those things that restrain or encourage individual actions, remembering that a wide variety of factors are likely to be involved, and that these will differ for each action under consideration.

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Figure 1 Wording and available responses for the final four items of questionnaire

Items	Available responses
How worried are you about what Global Warming might do to the environment?	I am very worried I am quite worried I am a little bit worried I am not worried at all
How much do you think you know about Global Warming?	I know a lot about global warming I know something about global warming I know a little about global warming I know almost nothing about global warming
How 'environmentally friendly' do you think you are? (How much do you think you 'take care of' the environment by the things you do?)	I am very environmentally friendly I am quite environmentally friendly I am a bit environmentally friendly I am not at all environmentally friendly
Do you think that Global Warming is really happening now?	I am sure global warming is happening I think global warming is happening I don't know whether global warming is happening or not I am think global warming is not happening I am sure global warming is not happening

Figure 2 Wording of the questionnaire items. The main items of the questionnaire displayed so that the 'pairing' of the items can be seen.

Themes	Items about the *Believed Usefulness of Action*	Items about the *Degree of Willingness to Act*
Direct actions		
Transport (use)	If people didn't use their cars so much, 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
Transport (type)	If people had smaller cars that used less petrol or diesel, global warming would be reduced	Even if it was not as fast or luxurious, I would try to get a car that uses less petrol or diesel
Power generation (renewable)	If more of our energy was produced from the wind, waves and sun, 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
Power generation (nuclear)	If more of our energy was produced from nuclear power stations, 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
The home (electricity use)	If people used less electricity in their homes, global warming would be reduced	To save electricity, I would switch things off at home when I didn't need them
The home (insulation)	If people got their homes insulated better, global warming would be reduced	Even though it cost me money, I would get extra insulation for my home
The home (consumer durables)	If people got things for their homes (like fridges and washing machines) that used less energy, 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
The home (consumables)	If people were prepared to buy fewer new things and make do with the old ones, 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
Environmentally-friendly (trees)	If more trees were planted in the world, global warming would be reduced	Even if I had to pay more taxes, I think there should be more trees planted in the world
Environmentally-friendly (recycle)	If people recycled things more, global warming would be reduced	Even if it was more trouble for me, I would recycle things rather than just throw them away
Food (Reducing meat)	If people eat less meat, global warming would be reduced	Even if I really liked meat, I would eat fewer meals with meat in them
Food (Reducing artificial fertilizers)	If farmers stopped using artificial fertilisers with nitrogen in them, global warming would be reduced	Even if it was more expensive, I would buy food grown without the use of artificial fertilisers
Indirect actions		
Environmental legislation	If politicians made the right kind of new laws, global warming would be reduced	I would vote for a politician who said they would bring in laws to reduce global warming, even though it would stop me doing some of the things I enjoy
Environmental taxation	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 increase taxes to pay for reducing global warming, even though it meant me having less money to spend
Environmental education	If people were taught more about it, global warming would be reduced	I would like to learn more about global warming, even though it would mean extra work for me
Environmental International cooperation	If there could be more agreement between different countries about not putting certain gases into the air, global warming would be reduced	Even though it might mean some inconvenience to me (like changing my job), I would vote for a politician who said they would sign agreements with other countries on global warming

The items of the questionnaire are displayed so that the 'pairing' of the items can be seen. In the actual questionnaire, the items were in random order, and paired items were in different orders in the two main sections.

Figure 3 Wording of the permissible responses to the two sets of items.

Believed Usefulness of Action If I thought an action would help global warming by…	Score	*Degree of Willingness to Act* then I would…	Score
by quite a lot	1.00	definitely do it	1.00
by a fair amount	0.75	almost certainly do it	0.75
by a small but useful amount	0.50	probably do it	0.50
by a very small amount - hardly noticeable	0.25	perhaps do it	0.25
by nothing at all really	0.00	probably not do it	0.00

The wording of the permissible responses is displayed 'matched'. This 'matching' suggests the minimum action ('then I would') that might reasonably be expected for a given belief about the usefulness of that action. The figures show the scores assigned to the different responses; these enabled various coefficients to be constructed.

Figure 4 Annotated graph to show relationship between the *Degree of Willingness to Act* and the *Believed Usefulness of Action*

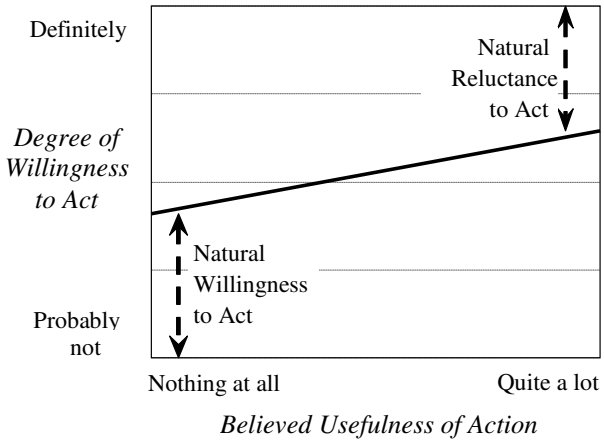
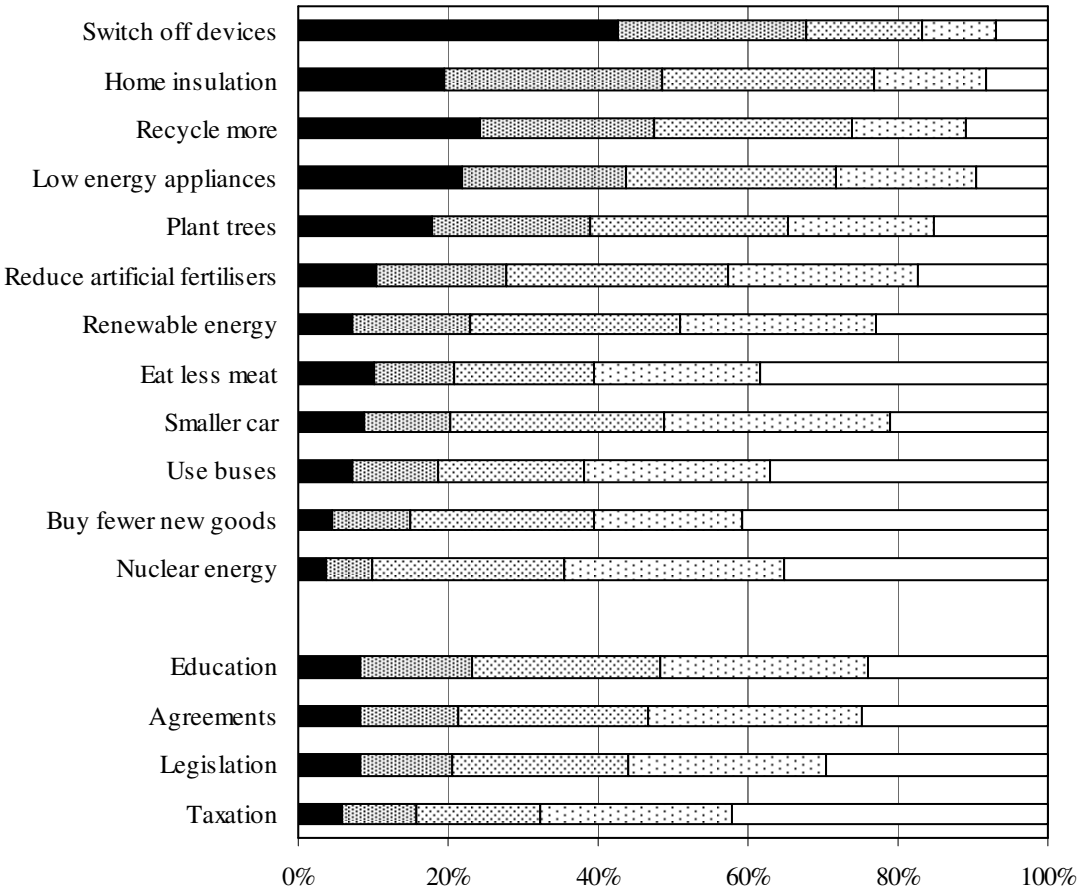


Figure 5 Secondary Students' willingness to undertake various pro-environmental actions, their beliefs about the usefulness of such actions and the relationships between these two measurements.

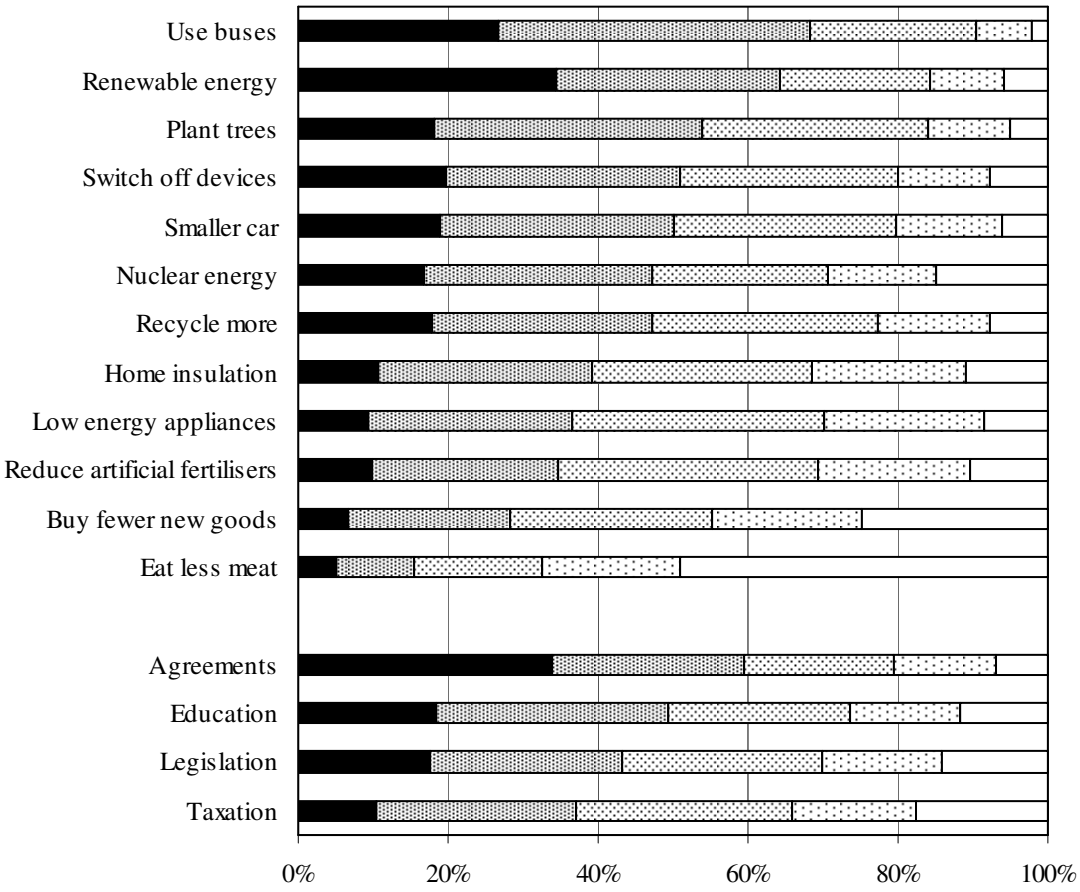
	Degree of Willingness to Act	*Believed Usefulness of Action*	*Potential Effectiveness of Education*	*Natural Willingness to Act*	*Natural Reluctance to Act*	*Potential Usefulness of Education*
	(% 'definitely' + 'almost certainly')	(% 'quite a lot' + 'a fair amount')	(Slope of *Degree of Willingness to Act* plotted vv *Believed Usefulness of Action*)	(Intercept when *Believed Usefulness of Action* is at minimum)	(Measurement between unity and the intercept when *Believed Usefulness of Action* is at maximum)	(*Potential Effectiveness of Education x* proportion of 'perhaps do it' and 'probably not do it')
Direct actions						
Smaller cars	20	50	0.17	0.29	0.54	0.09
Nuclear energy	10	47	0.15	0.20	0.64	0.10
Home insulation	49	39	0.25	0.46	0.28	0.06
Switch off unused devices	68	51	0.14	0.63	0.23	0.02
Plant trees	39	54	0.26	0.36	0.38	0.09
Recycle more	48	47	0.34	0.39	0.27	0.09
Reduce artificial fertilisers	28	35	0.27	0.31	0.42	0.12
Buy fewer new goods	15	28	0.15	0.23	0.62	0.09
Renewable energy	23	64	0.23	0.24	0.54	0.11
Use buses	19	68	0.18	0.19	0.63	0.11
Eat less meat	21	16	0.23	0.27	0.50	0.14
Low energy appliances	44	37	0.25	0.44	0.31	0.07
Indirect actions						
Legislation	21	43	0.23	0.24	0.54	0.13
Taxation	16	37	0.25	0.16	0.59	0.17
Agreements	21	59	0.24	0.23	0.54	0.13
Education	23	49	0.22	0.27	0.52	0.11

Figure 6 Secondary students' *Degree of Willingness to Act* to undertake different pro-environmental actions



For each action, the darkest bar, to the left hand side, represents the percentages of students who would 'definitely' undertake the action; the next, slightly lighter bar those who would 'almost certainly' undertake the action; the next, lighter bar, those who would 'probably' undertake the action; the next bar those who would 'perhaps' take the action; and the right hand, white bar, those who 'probably not' undertake the action. 'Direct' actions are in the upper section of the figure; 'indirect' actions are in the lower section. Within each section, actions are arranged in descending order of the combined percentages of students who would 'definitely' and 'almost certainly' take the action.

Figure 7 Secondary students' *Believed Usefulness of Action* of different pro-environmental actions



For each action, the darkest bar, to the left hand side, represents the percentages of students who responded that the action would reduce global warming by 'quite a lot'; the next, slightly lighter bar those who believe it would reduce global warming by 'a fair amount'; the next, lighter bar, those who believe it would reduce global warming by a 'small but useful amount'; the next bar those who believe it would reduce global warming by 'a very small, hardly noticeable, amount'; and the right hand, white bar, those who believe the action would reduce global warming by 'nothing at all'. 'Direct' actions are in the upper section of the figure; 'indirect' actions are in the lower section. Within each section, actions are arranged in descending order of the combined percentages of students who responded that the action would reduce global warming by 'quite a lot' and by 'a fair amount'.

Figure 8 Comparison of derived indices, *Natural Willingness to Act* and *Potential Effectiveness of Education* for two groups of students, those who are more or less concerned about global warming. The indices and categories are defined in the text.

	Natural Willingness to Act			*Potential Effectiveness of Education*		
Issue	More Concerned	Less Concerned	Sig	More Concerned	Less Concerned	Sig
Direct actions						
Smaller cars	**.40**	**.25**	**	.11	.12	
Nuclear energy	.22	.21		.18	.10	
Home insulation	**.54**	**.44**	*	.20	.23	
Switch off unused devices	**.75**	**.60**	**	.05	.09	
Plant trees	**.50**	**.30**	***	.18	.22	
Recycle more	**.51**	**.36**	**	.28	.28	
Reduce artificial fertilisers	**.41**	**.28**	**	.23	.20	
Buy fewer new goods	**.32**	**.19**	***	.10	.13	
Renewable energy	**.38**	**.18**	***	.14	.21	
Use buses	**.37**	**.15**	**	.07	.11	
Eat less meat	**.38**	**.20**	***	**.11**	**.28**	*
Low energy appliances	**.54**	**.41**	**	.18	.22	
Indirect actions						
Legislation	**.35**	**.21**	***	.20	.10	
Taxation	**.25**	**.13**	**	**.25**	**.11**	*
Agreements	**.32**	**.19**	**	.22	.16	
Education	**.42**	**.21**	***	.13	.15	

*** p<0.001 ** p<0.01 * p<0.05

Environmental education for behaviour change: which actions should be targeted?

ABSTRACT

One aim of environmental education is to enable people to make informed decisions about their environmental behaviour; this is particularly significant with environmental problems that are believed to be both major and imminent, such as climate change resulting from global warming. Previous research suggests no strong link between a person's general environmental attitudes and knowledge, and his or her willingness to undertake pro-environmental actions, so this study focuses on some *specific* issues. Using survey methods to produce quantitative data about students' beliefs concerning the usefulness of specific actions and their willingness to adopt them, novel indices have been constructed that indicate the potential of education to increase students' willingness to undertake those actions. The findings imply that altering a student's belief about certain issues will have little effect on their willingness to act. This can be because most students, even those with only a weak belief in the efficacy, are prepared to take action anyway. Conversely, it can be because a majority, including those convinced about the efficacy, is not prepared to take action. Education about such actions, where there is only a weak link between believed effectiveness and willingness to act, may be ineffective in terms of changing practice, because other factors such as social norms and situational influences dominate. For such actions other strategies may be required. For another set of actions, however, the benefits of education in changing practice seemed more positive; increasing recycling, reducing the use of artificial fertilisers and planting more trees are examples.

INTRODUCTION

"The literature on public understanding of climate change indicates widespread awareness of the issue and a general concern, but limited behavioural response"
(Lorenzoni, Nicholson-Cole & Whitmarsh, 2007)

Twenty years ago the scientific evidence for 'global warming' [1] was considered by some to be contentious (Stevenson, 1987; Boyes & Stanisstreet, 1993). Today, however, the weight of objective evidence has persuaded the majority of authoritative sources that the increase in global warming is a real phenomenon, caused by human-sourced greenhouse gases (IPCC, 1997), and that this is an increasing threat to the world's environmental integrity, social well-being (IPCC, 2001; 2007), economic stability (Stern, 2007) and political security (Solana, 2008). In view of these persuasive predictions, it is increasingly important to design and apply effective measures for reducing the emission of greenhouse gases, the primary drivers of global warming. In part, this will depend on central government policies. The UK government, amongst others, set ambitious targets to reduce by 12.5% (relative to 1990 levels) the levels of the major greenhouse gases by 2010, with a reduction by 20% for carbon dioxide in particular. Furthermore, the political goal is to reduce carbon dioxide by 60% by 2050 (DTI, 2003). Unfortunately, since these targets were set it has become apparent that the 20% reduction in carbon dioxide will not be achieved, throwing doubt on the attainability of the 2050 target of a 60% reduction (DEFRA, 2006).

In a complementary manner, it is estimated that about half of UK energy is used directly by individuals, for domestic use and personal transport. In these sectors, however, energy consumption is increasing (DEFRA, 2008a). What is needed, then, are mechanisms to persuade individuals to reduce their carbon contribution by limiting their energy use, because many individual-level actions can accumulate to produce environmentally significant impacts (Jensen and Schnack, 2006). Although there is disagreement about whether environmental education should

[1] In reality, the addition of anthropogenic pollutants to the atmosphere results in an exacerbation of the natural 'greenhouse effect' leading to 'global warming', the major effect of which is an alteration in the world's climate – 'climate change'. In this paper we have elected to use the term 'global warming' because it describes the primary consequence of this process.

encourage pro-environmental action or whether it should focus solely on knowledge and attitudes (Heimlich & Ardoin, 2008), it could be argued that, in view of the urgent call to reduce global warming, one of the aims of environmental education should be to engender in learners a preparedness to act in more environmentally sustainable ways (Mentzer & McEwen, 1999; Jurin & Fortner, 2002). Early models for encouraging environmental behaviour became known as 'information deficit' models (Burgess, Harrison & Filius, 1998). These were based on the assumption that if people understood more about the environment and the actions that would cause, or avoid, environmental degradation, they would behave in a rational manner and adopt environmentally sympathetic practices. In other words, it was believed that there was a relatively direct and positive relationship between a person's cognitive base about environmental problems and his or her willingness to act in such a way as to reduce these problems. Other models suggested a less direct link, in which action is influenced by both an intention to act and situational factors (Hines, Hungerford and Tomera, 1986-7). Some studies have shown that knowledge and behaviour are indeed related (Yencken, 2000). In many other cases, however, it seems that the relationship between knowledge and action is not robust (Rajecki, 1982; Hungerford & Volk, 1990; Posch, 1993), and it is acknowledged that there is what has come to be known as a 'gap' between cognition and action (Kollmus & Agyeman, 2002). In part, this 'gap' is due to the fact that behaviour is influenced by a plethora of other factors, not just knowledge; other beliefs, social pressures, physical facilitators and inhibitors can synergistically influence whether or not a particular action is pursued (Corraliza & Berenguer, 2000). Similarly, descriptive and injunctive social norms, standards by which actions are perceived as normally being undertaken, or as being approved or disapproved of, can influence whether or not a person acts in an environmentally sympathetic fashion (Cialdini, Reno & Kallgren, 1990). Perhaps most relevant to the present study is the finding that situational influences such as a person's belief in their own self-efficacy also partly determine the extent to which he or she acts in a pro-environmental manner (Devine-Wright, Devine-Wright & Flemming, 2004; Laskova, 2007). Despite these complications, many of these other factors are

themselves influenced by the cognitive base of the individual concerned, and thus potentially affected by education.

A further issue that has emerged as researchers have attempted to generate models of the incentives and disincentives to pro-environmental behaviour is that there are limitations in studying links between *general* environmental attitudes and potential behaviour patterns (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980; Dietz, Stern & Guagnano, 1998; Stern, 1992). Given this complexity, and a pressing need for a reduction in the emission of anthropogenic greenhouse gases, we have attempted to explore the role that education about the usefulness of *specific* pro-environmental actions might play in eliciting changes in the practices of individuals. We have designed an instrument that questions respondents about their willingness to undertake *specific* pro-environmental behaviours and, separately, their beliefs about the possible benefits of these particular behaviours in the context of one environmental problem - global warming. Three research questions have been addressed. Firstly, the degrees to which students report being willing to undertake a variety of specific pro-environmental actions have been ascertained. Secondly, the extents to which students believe these particular actions would be effective in reducing global warming have been investigated. Thirdly, the relationship between these two parameters, students' reported willingness to undertake specific actions and their beliefs about the usefulness of the same actions, has been explored. In addition, measures were sought of students' degree of concern about global warming, and the extent to which they thought that it was a real phenomenon. The overall aim was to determine the extent to which increasing students' understanding about the efficacy of specific actions might persuade individuals to increase their willingness to undertake those actions, so that education for changes in practice might be targeted for greatest efficacy.

METHODS

This study employed a novel questionnaire to probe the views of secondary students. The study was initiated in the UK, but has since been extended to Australia, the USA and a number of countries in mainland Europe; here we report the findings of the UK study.

Design of the questionnaire

The questionnaire consisted of a coversheet, two main sections and a short final section. The coversheet asked respondents to record their grade and gender. Each of the two main sections of the questionnaire contained 20 items, 16 of which were about actions that would contribute to the amelioration of global warming, and four of which were distracters that were more idiosyncratic in nature. The latter were derived from ideas that had been raised by students themselves in earlier research (Boyes & Stanisstreet, 1993), and were included so that respondents would not feel obliged to respond positively to all questions (Oppenheim, 1992; Parmenter and Wardle, 2000). The results from these four items will not be considered in this paper. The other 16 actions were selected to provide a reasonably comprehensive coverage of the things that could, to varying degrees, reduce global warming. Although this was not an exhaustive list, the actions chosen were considered to be representative and are generally accepted as important (US EPA, 2010). Most of the ideas in these items 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 concerned indirect actions, such as supporting increased environmental taxation or legislation. The section at the end of the questionnaire contained items designed to probe the level of students' concern about global warming, the extent of their perceived knowledge about global warming, the degree to which they considered themselves to be environmentally 'friendly', and whether or not they believed that global warming was a real phenomenon that was already happening. These final four questions, and the available responses, are shown in Figure 1.

We now consider the two main sections of the questionnaire. Because the aim of the questionnaire was to explore, in a quantitative manner, possible links between belief in the efficacy of specific behaviours and a willingness to undertake those same behaviours, both the structure of the questionnaire, and the wording of the items and responses in these two sections had to be constructed *de novo*. The focus of the first main section was the degree to which students would be willing to undertake a particular action, in the words of the coversheet of the questionnaire, "for the sake of the environment and the future of the Earth"; no mention was made of global warming at this stage. Each item took the form of a conditional clause indicating the personal cost or inconvenience of the action, followed by a simplified description of the action. The wording of the items can be seen in the right hand column of Figure 2, and the available responses to these items, which ranged from "I would definitely do it" to "I would probably not do it", and the ways in which they were scored, are shown in the right side of Figure 3. The scored responses produced by the items in this section of the questionnaire were designated students' *Degree of Willingness to Act*.

The items in the second main section of the questionnaire concerned the same pro-environmental actions as those in the first main section, although the order was different so that the pairing of the questions was not immediately apparent to the respondents. Here, however, the focus of the questioning was on the extent to which respondents believed that the actions were useful in alleviating global warming. The wording of these items can be seen in the left column of Figure 2, and the available responses, which ranged from "quite a lot" to "nothing at all really", and the ways in which they were scored, are shown in the left side of Figure 3. The scored responses were designated students' *Believed Usefulness of Action*.

Figure 2 also illustrates the pairing of the items and the themes within the questionnaire. In addition to the items being paired, the available responses in the two main sections of the questionnaire were designed to 'match', in semantic terms. Figure 3 illustrates this, where the two

response scales are shown in apposition. If, for example, a student believed that a particular action would help by 'quite a lot', this was matched in the other section of the questionnaire to the response that they would 'definitely' be willing to do it; each of these responses received a score of 1. Conversely, if a student believed that an action would reduce global warming 'by nothing at all', this is matched to the action section response that they would 'probably not' do it, and both responses received a score of zero. The intermediate responses were also designed to correspond in a similar way, semantically and by score.

The final wording of the paired questionnaire items and matched response scales came about from a series of discussions with a group of researchers and teachers. Throughout the questionnaire, the term 'global warming' was employed, although in the instructions to students the term 'climate change' was included in parentheses. In individual items, however, the term 'global warming' alone was used because it was felt to be most closely linked to the primary cause of this environmental problem, and the focus of this study was to explore students' willingness to undertake actions which might contribute to potential solutions.

The questionnaire was trialled with 134 students (age 14 years). The students completed the questionnaire in normal classroom situations in the presence of their usual class teacher, who then elicited feedback from them. Following discussions between the authors, the teacher and a wider research group, the only modification deemed necessary was the rephrasing and clarification of the pair of questions concerning home insulation.

Construction of the indices

From the responses to the two main sections of the questionnaire, the *Degree of Willingness to Act* and *Believed Usefulness of Action*, a number of derived indices were produced that have been used to explore the connections between them. Although the two response scales are ordinal and

although they measure different things, it was felt that because of their semantic matching (Figure 3), some mathematical manipulation of the data is acceptable; this is explored below.

Potential Effectiveness of Education

The indices we wish to focus on here relate to the extent to which increasing the understanding about the efficacy of a particular action through specific environmental education might persuade individuals within a cohort to undertake that action. To obtain the indices for a particular action, student measures of the *Degree of Willingness to Act* were plotted against their value of the *Believed Usefulness of Action*, and the trend line was fitted. This produced a graph of the type exemplified in Figure 4. The semantic matching of the responses means that linear regression is less sensitive to the errors involved in using ordinal scales. The slope of such a trend line indicates the extent to which the willingness of students to undertake an action might be said to be dependent upon their belief in the usefulness of that action. The gradient, therefore, provides a measure of the extent to which willingness to undertake an action might be increased by persuading students of the environmental effectiveness of that action; we have called this gradient, in the present context, the *Potential Effectiveness of Education*. Once the gradient of the line has been determined for a pair of questions, two other derived indices can be calculated from the intercepts. The intercept when the *Believed Usefulness of Action* is zero represents the likely action of those students who believed that such an action would be ineffective in reducing global warming; we term this the *Natural Willingness to Act,* and Figure 4 is annotated to show this. In a complementary fashion, the distance marked *Natural Reluctance to Act* in Figure 4 is a measure of the extent to which students will not take action, even though the *Believed Usefulness of Action* is at its maximum. These three indices may be useful in comparing the potential effect of education about different specific pro-environmental actions in terms of changing practice.

Comparing the values of the *Potential Effectiveness of Education* for different actions gives an indication of those actions for which education about their usefulness might lead to an increased willingness to act, and other actions where education will probably be less effective in this role. On a population basis, however, there is another measurement that will influence the efficacy of education to this end, namely the proportion of the population who are not already reporting an intention to take action. Thus, education might be most productive in terms of changing practices if directed at those actions that relatively few of the population are already willing to undertake. A final index was therefore calculated, the *Potential Usefulness of Education*, by multiplying the *Potential Effectiveness of Education* by the proportion of students in who would 'probably not' or only 'perhaps' undertake the action.

RESULTS

In all, 961 students in Grades 6 (11-12 years old) to 10 (15-16 years old) (UK National Curriculum Year Groups 7 through 11) from four state Community Comprehensive schools in the North West of England completed the questionnaire. Of this sample, 18% were in Grade 6, 23% were in Grade 7, 25% were in Grade 8, 17% were in Grade 9, and 17% were in Grade 10. Males comprised 52% of the cohort, females 48%; males and females were evenly distributed over the years. The responses to the final four questions provided some background information about the beliefs and views of the students. Some 61% of the students thought or were sure that global warming was happening, with half of this figure (31%) being sure of this. About half of the students expressed concern about global warming, with 16% reporting being 'very worried' and a further 33% reporting being 'quite worried'. Few students, about 14%, thought that they were well informed (knew 'a lot') about global warming, although a further 39% considered they knew 'something' about it. Nearly half of the cohort (45%) thought of themselves as being either 'very' or at least 'quite' environmentally friendly. Thus, many of this group of students believed that global

warming is a real phenomenon, few thought that they were especially well informed about it, and about half were concerned about its consequences.

In the descriptions that follow, overall results for the complete cohort are reported first. Following this, statistically significant differences between the responses of male and female students and between students of different grades are described.

Students' *Degree of Willingness to Act*

The findings concerning students' *Degree of Willingness to Act* for different pro-environmental actions are given in the first column of Figure 5 and illustrated graphically in Figure 6. In Figure 6, the items are arranged in descending order according to the combined percentages of students who would 'definitely' or 'almost certainly' undertake the action; in the descriptions below, these same percentages are reported. The direct action to which most students were amenable (68%) was to switch off un-used electrical appliances. The prospect of installing home insulation was acceptable to about half of the students (49%), as were the ideas of recycling materials (48%) and paying more for energy-efficient domestic appliances (44%). Over a third of the cohort (39%) were willing to pay for more tree-planting, although fewer (28%) would accept the increased price premium for food grown without artificial fertilisers, and even fewer (21%) would be prepared to reduce their consumption of meat. In terms of personal transport, only about a fifth of the students (20%) would consider getting a smaller car and a similar proportion (19%) would accept reducing car use by using public rather than private transport. Rather few of the students (15%) would accept buying fewer fashion items. In terms of energy production, very few students (10%) felt that using nuclear power was acceptable, perhaps because other environmental issues are associated with nuclear energy. In addition, and perhaps surprisingly, relatively few respondents (23%) would consider paying more for renewable energy sources. Most of the indirect actions were also unpopular. Only about a quarter of the students would be prepared to undertake more education about environmental

issues (23%) or allow their vote to be influenced by support for new environmental legislation (21%), international agreements (21%) and, for even fewer, increased environmental taxation (16%). Thus, students appeared willing to undertake different environmental behaviours to varying extents. There was a strong association between most of the 16 *Degree of Willingness to Act* items and the question in the third section of the questionnaire about the extent to which students were worried about global warming; this will be discussed later.

Students' *Believed Usefulness of Action*

Items in the second main section of the questionnaire explored students' beliefs about the usefulness of the various actions in reducing global warming, their *Believed Usefulness of Action*, and the data from the responses are given in the second column of Figure 5 and illustrated graphically in Figure 7. In Figure 7, the items are arranged in descending order according to the combined percentages of students who thought that the action would reduce global warming by 'quite a lot' or by 'a fair amount'. In the descriptions that follow, these same percentages are reported. Students apparently made a link between global warming and personal transport; two actions thought by many of the students to contribute to a reduction in global warming were to reduce car use (68%) and drive smaller cars (50%). Energy production also seemed to be linked with global warming in students' minds, since many believed that production of energy from renewable sources (64%) and from nuclear sources (47%) could play a role in reducing global warming. Perhaps linked to this, another relatively popular idea was energy conservation by switching off unused electrical items (51%). Surprisingly, rather fewer students realised that installing home insulation (39%) or the use of energy-efficient domestic appliances (37%) could reduce global warming. Tree planting was also thought to contribute to decreasing global warming by more than half of the students (54%), and almost as many (47%) appreciated the role that increased recycling could play. Rather fewer of the students (35%) realised that reducing the use of artificial fertilisers and decreasing meat consumption (16%) could lessen global warming, perhaps

because the mechanisms involved gases other than carbon dioxide, the latter being perhaps the most well-known greenhouse gas. Relatively few students (28%) realised that buying fewer new items could help to reduce global warming; this may be because fewer students appreciated the carbon cost of manufacturing and distributing new consumer goods. Of what we have termed the 'indirect actions', those related to international agreements were thought to be the most effective (59%), with education (49%), legislation (43%) and taxation (37%) being thought less so. Thus, students believed that the various environmentally-friendly actions that had been suggested in the questionnaire would be differentially effective in reducing global warming.

Relationship between the *Degree of Willingness to Act* and *Believed Usefulness of Action*

As explained above, a number of indices can be obtained from the responses to the two main sections of the questionnaire, where the scored items were called the *Degree of Willingness to Act* and the *Believed Usefulness of Action*. Some of these will now be discussed.

The *Potential Effectiveness of Education* provides an indication of the extent to which increasing understanding about particular actions through specific environmental education might persuade individuals to undertake those actions. This relationship was quantified by linear regression, and the results are illustrated schematically in Figure 4; the values of the indices from the regression are summarised in the last four columns of Figure 5. The first of these, the slope of the regression line constructed when the *Degree of Willingness to Act* and the *Believed Usefulness of Action* for pairs of actions are plotted, has been designated the *Potential Effectiveness of Education*; a high value of this index represents a steep relationship between the extent to which students believe an action to be effective and their willingness to undertake that action. In such cases, persuading students of the efficacy of the action should result in more students purporting to take that action. Where the relationship is shallower, indicated by a lower value of the *Potential Effectiveness of Education*, education about the action is less likely to result in more students from this cohort adopting it.

There are two other two indices shown on the vertical axes in Figure 4. The first, the *Natural Willingness to Act*, provides an indication of the extent to which students will undertake the action even when they believe it to be ineffective. The second, the *Natural Reluctance to Act*, shows the extent to which students will avoid the action even if they believe it is highly effective. Each of these indices can take a value between zero and one.

Figure 5 shows that for some actions the value of the slope of the line, the *Potential Effectiveness of Education*, was low, suggesting that there was little change in the willingness to undertake an action for different beliefs in the effectiveness of that action. For example, this was true for the action of switching off unused electrical items (0.14). In this case, the slope of the line was shallow because the *Natural Willingness to Act* was relatively high (0.63); students were prepared to take this action in any case. Here, it is likely that other motivators, such as parental exhortations to reduce electricity bills, coupled with a relatively low level of inconvenience, meant that students would be taking this action anyway. The value of the *Potential Effectiveness of Education* was also fairly low for some other actions such as adopting more nuclear power (0.15), reducing car use (0.18), avoiding buying new fashion items (0.15) or purchasing smaller cars (0.17). In these cases, however, the slope of the line was shallow because the *Natural Reluctance to Act* tended to be quite high; even if students believed these actions to be effective in reducing global warming, they seemed unwilling to undertake them. For issues such as these it is probable that other disincentives, such as major inconvenience, substantial changes in lifestyle or environmental and health concerns, would prevent students taking these actions. In yet other cases there was a steeper association between a belief in the effectiveness of an action and a willingness to undertake it. Increasing the amount of material that is recycled (0.34), reducing the use of artificial fertilisers (0.27) and tree planting fell into this category (0.26). For these, the *Natural Willingness to Act* and the *Natural Reluctance to Act* were both relatively low, and so the slope of the line was fairly steep. For these specific actions, then, although many other factors affect behaviour, the data indicate that educating

students about the effectiveness of the action might well result in more of the students adopting the action. In summary, there are some pro-environmental actions that will probably not be induced by convincing students of their efficacy, and there are others that probably will.

There is another factor that will impinge upon the degree to which environmental education might be effective on a population level. In terms of behaviour change, the overall effectiveness of such education will be maximised when directed at those actions that a high proportion of the population are not already undertaking. In an attempt to give some quantitative comparison to the various actions raised in the questionnaire, a final index, the *Potential Usefulness of Education,* was constructed by multiplying the *Potential Effectiveness of Education* by the proportion of students who would 'probably not' or only 'perhaps' undertake the action; these data are shown in the final column of Figure 5. This multiplication produces much smaller numbers, but the bigger of these indicate that teaching about the effects of reducing meat consumption (0.14), lowering the use of artificial fertilisers (0.12), decreasing car use (0.11) and increasing the proportion of energy generated from renewable sources (0.11) should be useful areas on which to concentrate teaching.

Differences between subsets of students

Differences between various groupings of students were investigated in a number of ways. ANCOVA was used for the basic scores on the 32 items when exploring, simultaneously, differences between the responses of male and female students, and students in different grades. ANCOVA can be used not only to analyse the effect of several categorical independent variables on a dependent variable (ANOVA) but can include one or more continuous variables which may predict the dependent variable. In this case grade was used as a more or less continuous variable. For the derived indices, gradient and intercept were compared for any two groups using the standard technique of dummy variable creation and fitting a multiple linear regression model against the independent variable, the comparison variable (dichotomous) and the derived variable. Differences

revealed by any of these tests are noted below. When discussing these differences, the percentage of the top two categories will be reported for the main questions (defined as in the first two columns of Figure 5), whereas the derived indices will simply have their values compared (explained in the later columns of Figure 5).

Differences between male and female students

In this section, the first figures in brackets will be those for the males, followed by those for the females. For the *Degree of Willingness to Act* items, more females than males were prepared to take action on some issues; this included switching off unused electrical items (65%, 71%, $p<0.05$), reducing car use (15%, 23%, $p<0.05$) and eating less meat (15%, 27%, $p<0.001$). In the case of items to determine the *Believed Usefulness of Action*, three issues showed that females had a greater belief in using energy-efficient domestic white goods (33%, 40%, $p<0.01$), reducing the purchase of new fashion items (26%, 31%, $p<0.05$) and taking into account a politician's willingness to legislate on the environment when voting (38%, 48%, $p<0.01$).

Measures of the *Potential Effectiveness of Education*, showed only one difference between the genders and that was for the question relating to international agreements (0.15, 0.33, $p<0.01$), where females appeared more likely to have their behaviour influenced by their understanding or belief. For two issues there were significant differences in the *Natural Willingness to Act*; for eating less meat females showed a greater inherent compliance (0.22, 0.31, $p<0.001$), but they seemed less naturally willing to vote in accordance with politicians' views on international environmental agreements (0.29, 0.15, $p<0.01$).

Differences between students in different grades

Differences between students in different grades are reported below only if ANCOVA revealed statistically significant differences giving a trend across the grades. In the descriptions that follow,

the percentage figures quoted are for the top two categories of response across Grades 6, 7, 8, 9 and 10. Within the 16 *Degree of Willingness to Act* items, there were 6 significant and reasonably consistent trends downwards across the grades. These were: switching off unwanted appliances (81%, 65%, 63%, 69%, 66%, $p<0.01$), purchasing foods cultivated without artificial fertilisers (34%, 35%, 18%, 30%, 24%, $p<0.001$), eating less meat (28%, 28%, 14%, 16%, 19%, $p<0.001$), buying more efficient appliances (56%, 46%, 36%, 45%, 40%, $p<0.001$) and voting for politicians in light of their policies on 'green' legislation (34%, 24%, 14%, 18%, 17%, $p<0.001$) and their support for international environmental agreements (36%, 21%, 15%, 20%, 18%, $p<0.001$).

In the other main section of the questionnaire, the *Believed Usefulness of Action*, there were also a number of differences that for the most part showed a decrease over the grades. So, fewer of the older students believed that global warming would be reduced (by 'quite a lot' or by 'a fair amount') by adopting the use of smaller cars (57%, 55%, 52%, 51%, 33%, $p<0.001$), insulating homes (44%, 45%, 42%, 39%, 21%, $p<0.001$), switching off un-used electrical items (61%, 57%, 48%, 48%, 39%, $p<0.001$), recycling more (54%, 60%, 47%, 37%, 33%, $p<0.001$), helping to reduce the use of artificial fertilisers (35%, 46%, 37%, 29%, 22%, $p<0.001$), buying fewer fashion items (35%, 33%, 27%, 25%, 21%, $p<0.001$), reducing car use (76%, 70%, 65%, 71%, 58%, $p<0.001$), eating less meat (19%, 21%, 16%, 8%, 10%, $p<0.001$) or using energy-efficient domestic appliances (47%, 42%, 31, 39%, 25%, $p<0.001$). Confidence in the effectiveness of most of the indirect actions also declined over the grades. Thus, fewer of the older students saw the benefit, with regard to global warming, of voting in accordance with promises on environmental legislation (53%, 46%, 38%, 45%, 36%, $p<0.01$) and taxation (47%, 38%, 34%, 38%, 27%, $p<0.001$), and international agreements (72%, 60%, 55%, 60%, 51%, $p<0.001$).

There were a number of differences across the grades in the *Potential Effectiveness of Education*, as tested using two groups of students (top two and bottom two grades) and the standard technique

described earlier. Generally, the analysis showed increases in the *Potential Effectiveness of Education* across the grades; this included the actions of planting trees (0.19, 0.16, 0.21, 0.28, 0.50, $p<0.05$) and increasing adoption of renewable energy (0.16, 0.23, 0.09, 0.24, 0.38, $p<0.05$). Although it is known that the knowledge-behaviour link is weak (Kollmus & Agyeman, 2002), it would appear from these findings that it is stronger for the older students, and would suggest perhaps that teaching about the efficacy of these specific actions might be more effective with older school students than with their younger counterparts. This trend was also evident in two of the indirect actions, related to supporting international agreements (0.16, 0.20, 0.11, 0.19, 0.43, $p<0.05$) and being prepared to undergo more environmental education (0.19, 0.10, 0.18, 0.25, 0.36, $p<0.05$). However, it was also noticed that for these, and only these issues, the *Natural Willingness to Act* started high and decreased across the grades, as the *Potential Effectiveness of Education* increased. The conclusion would seem to be that adolescents' views retain a degree of flexibility about these issues, with younger students being generally less discriminatory, and having a high willingness to act regardless of their belief in the efficacy of an action, whereas older students seem to show a response in their intended actions which is more in line with their understanding.

Differences between more and less concerned students

Finally, the relationship between the extent of students' concern about global warming and their willingness to act in various pro-environmental manners was investigated. Students were grouped according to their responses to a question in the final section of the questionnaire about how worried they are about global warming. Those who indicated that they were 'very' or 'quite' worried were considered to be 'more concerned' (n=452); those who responded that they were 'a little bit worried' or 'not worried at all' were considered to be 'less concerned' (n=460).

Rather than examine how these two groups responded to the *Degree of Willingness to Act* variables, which inevitably contain information about students with different degrees of *Believed Usefulness*

of Action, we elected to focus on the extent to which being more or less worried might affect students' inherent willingness to take action, their *Natural Willingness to Act*. When the 16 regressions were performed for the two groups of students, and the indices compared using the dummy variable technique mentioned earlier, it became apparent that the values for the *Natural Willingness to Act* indices were consistently higher for the more concerned students than for those who were less concerned; this was true for all actions other than the increased adoption of nuclear power. Figure 8 shows the details for all the differences measured, where one may recall that the *Natural Willingness to Act* mapped on to a scale with five values, from zero ('probably not') to one ('almost certainly').

In contrast to these differences, only two of the values of *Potential Effectiveness of Education* showed statistically significant differences between the two groups, and these differences were relatively small. It seems clear from Figure 8 that, regardless of the degree of worry about global warming, the sense in which action might be influenced by understanding or belief is fairly stable (though different for each issue). On the other hand, the *Natural Willingness to Act*, the likely action even when it is believed to be ineffective, is significantly greater for almost all issues for those who are more concerned about global warming. Research on students' views about air pollution suggest that worry can have a considerable influence on the stated willingness to take certain environmental actions, particularly in some cultures (Boyes, Stanisstreet, Myers, Skamp & Yeung, 2007). The results of the present study further indicate that worry about global warming and its consequences is indeed likely to precipitate action, independent of whether or not it is thought to be helpful.

DISCUSSION

Research of this nature inevitably has some limitations. For example, the fact that we wished to encompass in this study a reasonably comprehensive range of actions that could, in reality,

contribute to a reduction in global warming, inevitably led to a number of consequences. Firstly, this meant that some of these actions were out of the current locus of control of secondary students, who will assume the capacity to take them only later in life. For example, students in this age group will not be able to vote yet about environmental taxation or legislation, or be directly able to purchase energy-efficient consumer durables, although their views may have some influence on parental decisions. Furthermore, whether or not students are able to undertake a particular action may have some influence on their stated intention to take it. Secondly, the selected actions varied in terms of the directness of their link to a reduction in global warming. Use of smaller cars, for example, has a fairly obvious link to a reduction in carbon dioxide emission, whereas the link between purchasing fewer consumer goods and reducing global warming is more circuitous and requires an awareness of the production of greenhouse gases in manufacture and distribution. Thirdly, some of the issues represented in the questionnaire, such as the extended use of nuclear power, have counter-balancing environmental arguments, whereas others do not. For all of the actions, one can argue that any response of an individual indicating that they intend to act will not necessarily mean that they will do so (Downing & Ballantyne, 2007), although it is unlikely that an individual who states an intention not to take an action will then take it. Finally, although gaining any absolute measure of attitudes or intentions is problematic (Reid, 2006), the instrument devised does enable attitudes and intentions to a series of pro-environmental actions to be compared.

Approximately two thirds of the students in this study believed that global warming is a real phenomenon, paralleling the high general awareness of global warming in the adult population (MORI, 2004). Furthermore, about half of the respondents expressed concern about the consequences of global warming, again similar to the adult population (PEW Research Centre, 2009), suggesting that consciousness of, and concern about, global warming are beginning to develop early. Perhaps because of anxiety about the issue, UK adults in general appear to support, in principle at least, both individual and political action to reduce global warming (BBC, 2007);

about half of the UK population believe that modifying individuals' practices would be effective. In a complementary manner, a proportion of the adult population in general would support the introduction of further environmental legislation, partly because this is seen as fairer, but also because it means that pro-environmental behaviour does not rely only on an individuals' willingness to act (Darier & Schule, 1999).

In the context of these general attitudes, the findings of the present study indicate that among UK secondary students there is a differential willingness to undertake different pro-environmental actions - what we have termed the *Degree of Willingness to Act*. Among the more direct actions, for example, many students report a willingness to switch off unused electrical items in the home, whereas far fewer are prepared to alter their practices concerning personal transport by using public rather than private transport, or by accepting the use of smaller, more energy-efficient private vehicles, unless they are particularly worried about global warming. The differential willingness to undertake diverse pro-environmental actions is similar to that reported for adults, who are more prepared to increase recycling or to take action to conserve energy in domestic situations, but less willing to modify their travel habits (Shackley, McLachlan & Gough, 2004; Kasemir *et al*, 2003; O'Connor, Bord & Fisher, 1999). Each of the pro-environmental actions raised in this study has associated incentives and disincentives for young people, the nature and extent of which will differ between different actions. These motivators and inhibitors stem from a plethora of sources, including beliefs, social pressures (Cialdini, Reno & Kallgren, 1990), social background (Pruneau *et al*, 2007), characteristics of the physical context (Corraliza & Berenguer, 2000) and a person's action competence (Jensen & Schnack, 2006).

This range of motivators and inhibitors means that the likelihood of undertaking any particular pro-environmental action is the result of an interaction between a general feeling of benefiting the environment, coupled with more concrete personal incentives, disincentives and concerns.

Switching off un-used electrical items, for example, causes only minor inconvenience so carries few such inhibitors. In addition, it may carry an incentive in that it aligns with parental exhortations to 'save electricity' for financial reasons. Use of public transport, on the other hand, may be perceived as carrying a major inconvenience and could be associated with a negative social image amongst school students' peer groups, with social norms acting as a disincentive (Cialdini, Reno & Kallgren, 1990). For indirect actions such as the influencing of voting patterns, rather few of the students seemed willing to consider increased environmental taxation, legislation or education or, perhaps surprisingly, even international agreements. Whilst it is unclear what voting priorities young people may have, a part of their general unwillingness to consider such issues may be because there is a tendency for them to distrust politicians (Smith, Stanisstreet & Boyes, 2005) and other authority figures (Stern, 2008). Such mistrust has major implications for a population that approves in principle of the introduction of pro-environmental actions by central government, but seems less willing to take this into account when voting.

The findings of the present study also indicate that students consider that different actions may have different levels of usefulness in reducing global warming, a measurement we termed the *Believed Usefulness of Action*. For example, reducing car use, generating electricity from renewable sources and switching off un-used electrical items were thought to contribute to reducing global warming. In addition, tree planting was seen as useful in this context. The prime effect of all of these actions relate to atmospheric carbon dioxide, either by decreasing carbon dioxide emissions or, in the case of tree planting, by increasing the rate of removal of carbon dioxide from the atmosphere. Decreasing the use of artificial fertilisers or reducing meat production was thought by students to be less effective. In these cases the greenhouse gases involved are nitrogen oxides and methane, respectively. It may be that the efficacy of such pro-environmental actions in terms of global warming may be less well appreciated because the contribution of these two gases to global warming is less well known than that of carbon dioxide (Boyes & Stanisstreet, 1993, 2001), the role

of which has been more recently re-enforced by phrases such as 'carbon footprint', 'carbon dependency' and 'carbon trading'. Students were also not strongly aware of the link between consumption of new 'fashion' items and global warming, perhaps because the energy consumed in their manufacture and transport to the point of purchase does not come immediately to the minds of young people.

By combining the data obtained from the two main sections of the questionnaire, the *Degree of Willingness to Act* and the *Believed Usefulness of Action*, it was possible to derive a series of novel indices to gain insight into the probable advantage, in terms of changing students' practices, of persuading young adults of the efficacy of different pro-environmental actions in ameliorating global warming. In particular, the *Potential Effectiveness of Education* is a measure, in the context of the present study, of the association between belief in the effectiveness of an action and the willingness to undertake it. Certain actions had rather low values for the *Potential Effectiveness of Education*, indicating that education might be less effective for such actions in terms of behaviour change. There are two reasons why the *Potential Effectiveness of Education* might be low. In some cases, such as switching off un-used electrical items, this was because students showed a high *Natural Willingness to Act* - they would perform such actions irrespective of a belief or not in their merit. In other cases a low *Potential Effectiveness of Education* was associated with a high *Natural Reluctance to Act.* Here, even a relatively strong belief in the efficacy of an action did not promote its uptake, presumably because there were other disincentives in place; the nature of such disincentives would, of course, vary between different actions. For example, adoption of nuclear power may show a high *Natural Reluctance to Act* because of fears about environmental or health impacts of nuclear power. Change in transport habits, such as the use of smaller cars or substitution of public for private transport, could be somewhat intractable because environmental sensitivity would be out-weighed in decision-making by preferences about lifestyle or personal convenience, an example of a physical inhibitor acting as a disincentive (Corraliza & Berenguiar, 2000). In

addition, students were resistant to reducing their purchase of new 'fashion' items, perhaps because consumption of this sort is perceived as a natural characteristic of their life-style. In such cases, where the *Potential Effectiveness of Education* is low, education alone might be of only limited benefit in terms of altering students' behaviour, although it might be a useful component in a series of measures. For example, introduction of potentially unpopular environmental legislation might be made more acceptable if there is a general understanding of why it is necessary.

In the case of other pro-environmental actions, there was a stronger relationship between the extent to which an action was believed to be effective in reducing global warming and a willingness to undertake it; in other words, the *Potential Effectiveness of Education* was higher. Increasing recycling, reducing the use of synthetic fertiliser, tree planting, installing home insulation and using energy-efficient domestic appliances were examples of these actions. The first of these might be especially relevant because this action is within the locus of control of individual young people. Indeed, it has been shown that in the case of health education (Wilcox *et al*, 1981: Croucher *et al*, 1985), young people may influence the practices of the family in which they live, even though the effect may be weak.

With virtually all of the issues, the rate at which intended action increased with belief about that action did not depend on how worried the students were about global warming. On the other hand, the extent to which the more worried students were prepared to take action even when they did not believe it to be effective, was considerably greater; that is, the *Natural Willingness to Act* was greater in the more concerned individuals. One possible explanation is that the more concerned students make an assessment that, even though they perceive the action as having little or no effect, it is worth taking 'just in case', because they worry about the outcome of inaction being so devastating. An alternative explanation is that the willingness to take action and the concern about the consequences of global warming may each be a reflection of a 'constellation' of underlying

attitudes (Heimlich & Ardoin, 2008), which includes students' perception of themselves as being pro-environmental; almost half of the students in the present study declared themselves to be 'environmentally friendly'. The one issue for which there was no difference between the declared intentions of worried and unconcerned students was the idea of being willing to pay more for electricity if it were produced by nuclear power. Perhaps, in the minds even of those students who are concerned about global warming, the risks associated with the proliferation of nuclear energy are more significant than the consequences of global warming.

In terms of persuading people to alter their behaviour, only a few of those who are at present unwilling to undertake actions would be amenable to changing their practices. The adult population can be considered to consist of various groups with different characteristic behaviours and attitudes (DEFRA, 2008b). Furthermore, research in the USA has suggested that society may be considered to consist of six 'segments', from the 'Alarmed' who are sure that global warming is happening and are worried about it, to the 'Dismissive' who consider that global warming is not happening and so regard changes in behaviour as unnecessary (Maibach, Roser-Renouf & Leiserowitz, 2009). Members of some of these segments are more amenable to change than others. A further index, the *Potential Usefulness of Education*, attempted to take account of the size of the potential education audience, that is, the proportion of students who did not already intend to undertake such actions. Actions with a high *Potential Usefulness of Education* were those for which intended behaviour appeared to be strongly influenced by a belief in their effectiveness (that is, the *Potential Effectiveness of Education* was high), and which a relatively high proportion of students are at present unwilling to undertake. Using this index, certain specific actions emerge as useful targets for education; a reduction in meat consumption (and therefore production) and a willingness to pay more for produce grown without the use of artificial fertilisers, together with a decrease in car use and production of energy from renewable sources were such actions. Thus, the *Potential Usefulness of Education* enables us to target actions which are not at present accepted by a large

proportion of the population. In a complementary manner, however, continuing environmental education directed towards those who are already prepared to take action is also necessary in order to reinforce and maintain their existing pro-environmental behaviour, particularly when this has been engendered through social marketing (Heimlich & Ardoin, 2008).

The present study reveals that for different actions there is a different degree of association between a belief in the efficacy of an action and a willingness to undertake it; this variation is one reason why environmental education in *general* might be less than fully effective in terms of behaviour change. Even in the case of specific actions, it is apparent that for some actions education to persuade learners of their usefulness in terms of a major environmental problem has little potential on its own to be effective in terms of modifying young people's practices.

Our research suggests that where there were differences between the responses of male and female students, females tended to be more sensitive to the benefits of certain pro-environmental actions, and more willing to undertake other pro-environmental actions. This is congruent with the observation that females tend to score more highly than males on instruments that measure of environmental attitudes (Burger *et al*, 1998; Taskin, 2009). The results also indicate that the degree of association between belief in the effectiveness of an action and a willingness to undertake it differs across different age groups of students. It appears, in contrast to our intuition, that older secondary students might respond more to teaching than their younger counterparts in terms of behaviour change. Perhaps a potential hazard, then, of initiating education about pro-environmental actions too early might be that of over-exposure; the possibility is that by the time that students reach their most receptive stage they may be in a state of environmental 'fatigue', in the same way that donors to charity are thought, eventually, to suffer 'compassion fatigue' (Gallup, 2009; Ker, 2009). In addition to the heterogeneity that could be linked to overt factors such as gender and year group, it appears that there is also an association between the level of concern among students about

global warming, and their willingness to undertake pro-environmental actions. Education strategists and practitioners should be aware, therefore, of this further heterogeneity within the student population; like adults (Lorenzini, Nicholson-Cole & Whitmarsh, 2007; DEFRA, 2008b), students will not be uniform in their behavioural responsiveness to environmental education even about specific actions.

The discrepancies between belief and willingness to act for different actions revealed in this study originate in the variety of other, sometimes non-environmental, incentives and disincentives associated with the various actions. It would be interesting, in further research, to investigate the detail of those things that restrain or encourage individual actions, remembering that a wide variety of factors are likely to be involved, and that these will differ for each action under consideration.

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Figure 1 Wording and available responses for the final four items of questionnaire

Items	Available responses
How worried are you about what Global Warming might do to the environment?	I am very worried I am quite worried I am a little bit worried I am not worried at all
How much do you think you know about Global Warming?	I know a lot about global warming I know something about global warming I know a little about global warming I know almost nothing about global warming
How 'environmentally friendly' do you think you are? (How much do you think you 'take care of' the environment by the things you do?)	I am very environmentally friendly I am quite environmentally friendly I am a bit environmentally friendly I am not at all environmentally friendly
Do you think that Global Warming is really happening now?	I am sure global warming is happening I think global warming is happening I don't know whether global warming is happening or not I am think global warming is not happening I am sure global warming is not happening

Figure 2 Wording of the questionnaire items. The main items of the questionnaire displayed so that the 'pairing' of the items can be seen.

Themes	Items about the *Believed Usefulness of Action*	Items about the *Degree of Willingness to Act*
Direct actions		
Transport (use)	If people didn't use their cars so much, 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
Transport (type)	If people had smaller cars that used less petrol or diesel, global warming would be reduced	Even if it was not as fast or luxurious, I would try to get a car that uses less petrol or diesel
Power generation (renewable)	If more of our energy was produced from the wind, waves and sun, 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
Power generation (nuclear)	If more of our energy was produced from nuclear power stations, 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
The home (electricity use)	If people used less electricity in their homes, global warming would be reduced	To save electricity, I would switch things off at home when I didn't need them
The home (insulation)	If people got their homes insulated better, global warming would be reduced	Even though it cost me money, I would get extra insulation for my home
The home (consumer durables)	If people got things for their homes (like fridges and washing machines) that used less energy, 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
The home (consumables)	If people were prepared to buy fewer new things and make do with the old ones, 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
Environmentally-friendly (trees)	If more trees were planted in the world, global warming would be reduced	Even if I had to pay more taxes, I think there should be more trees planted in the world
Environmentally-friendly (recycle)	If people recycled things more, global warming would be reduced	Even if it was more trouble for me, I would recycle things rather than just throw them away
Food (Reducing meat)	If people eat less meat, global warming would be reduced	Even if I really liked meat, I would eat fewer meals with meat in them
Food (Reducing artificial fertilizers)	If farmers stopped using artificial fertilisers with nitrogen in them, global warming would be reduced	Even if it was more expensive, I would buy food grown without the use of artificial fertilisers
Indirect actions		
Environmental legislation	If politicians made the right kind of new laws, global warming would be reduced	I would vote for a politician who said they would bring in laws to reduce global warming, even though it would stop me doing some of the things I enjoy
Environmental taxation	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 increase taxes to pay for reducing global warming, even though it meant me having less money to spend
Environmental education	If people were taught more about it, global warming would be reduced	I would like to learn more about global warming, even though it would mean extra work for me
Environmental International cooperation	If there could be more agreement between different countries about not putting certain gases into the air, global warming would be reduced	Even though it might mean some inconvenience to me (like changing my job), I would vote for a politician who said they would sign agreements with other countries on global warming

The items of the questionnaire are displayed so that the 'pairing' of the items can be seen. In the actual questionnaire, the items were in random order, and paired items were in different orders in the two main sections.

Figure 3 Wording of the permissible responses to the two sets of items.

Believed Usefulness of Action If I thought an action would help global warming by…	Score	*Degree of Willingness to Act* then I would…	Score
by quite a lot	1.00	definitely do it	1.00
by a fair amount	0.75	almost certainly do it	0.75
by a small but useful amount	0.50	probably do it	0.50
by a very small amount - hardly noticeable	0.25	perhaps do it	0.25
by nothing at all really	0.00	probably not do it	0.00

The wording of the permissible responses is displayed 'matched'. This 'matching' suggests the minimum action ('then I would') that might reasonably be expected for a given belief about the usefulness of that action. The figures show the scores assigned to the different responses; these enabled various coefficients to be constructed.

Figure 4 Annotated graph to show relationship between the *Degree of Willingness to Act* and the *Believed Usefulness of Action*

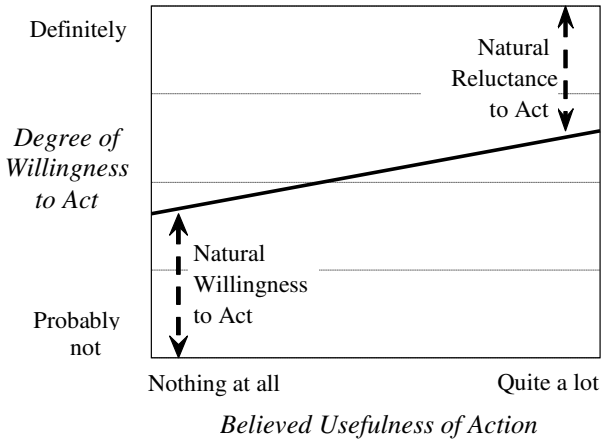
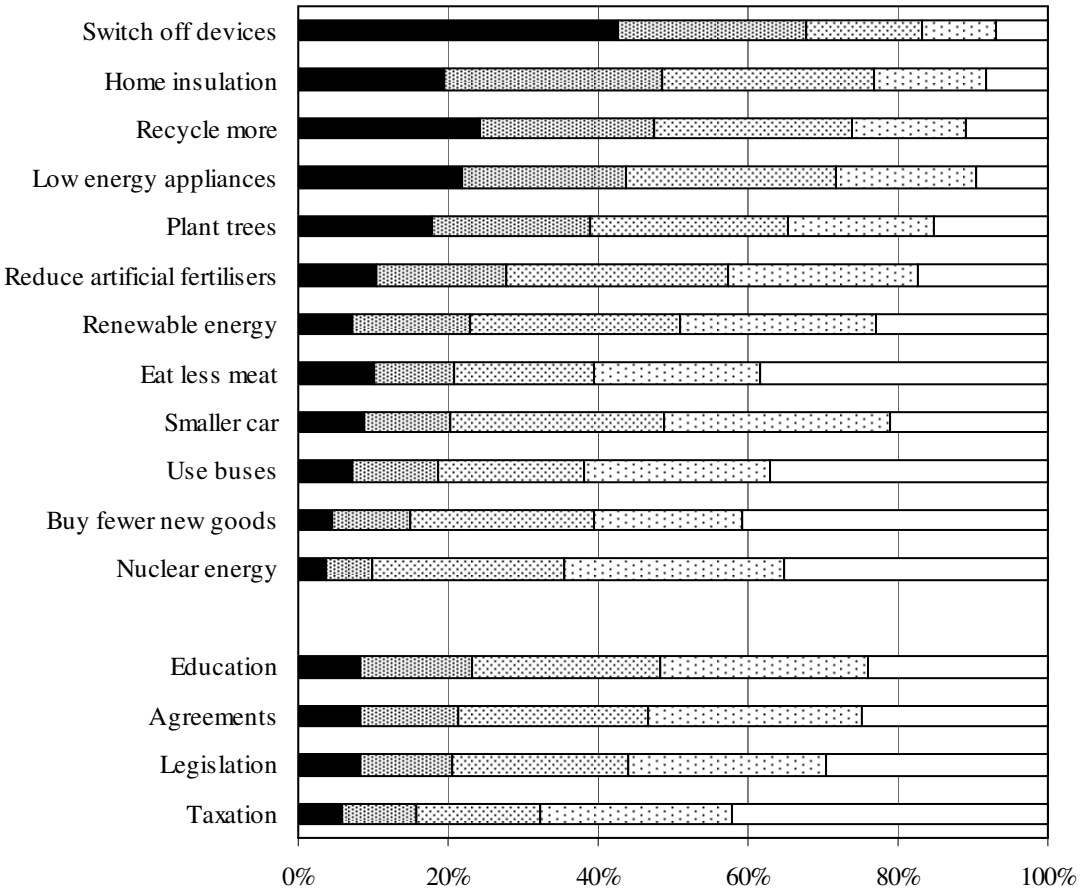


Figure 5 Secondary Students' willingness to undertake various pro-environmental actions, their beliefs about the usefulness of such actions and the relationships between these two measurements.

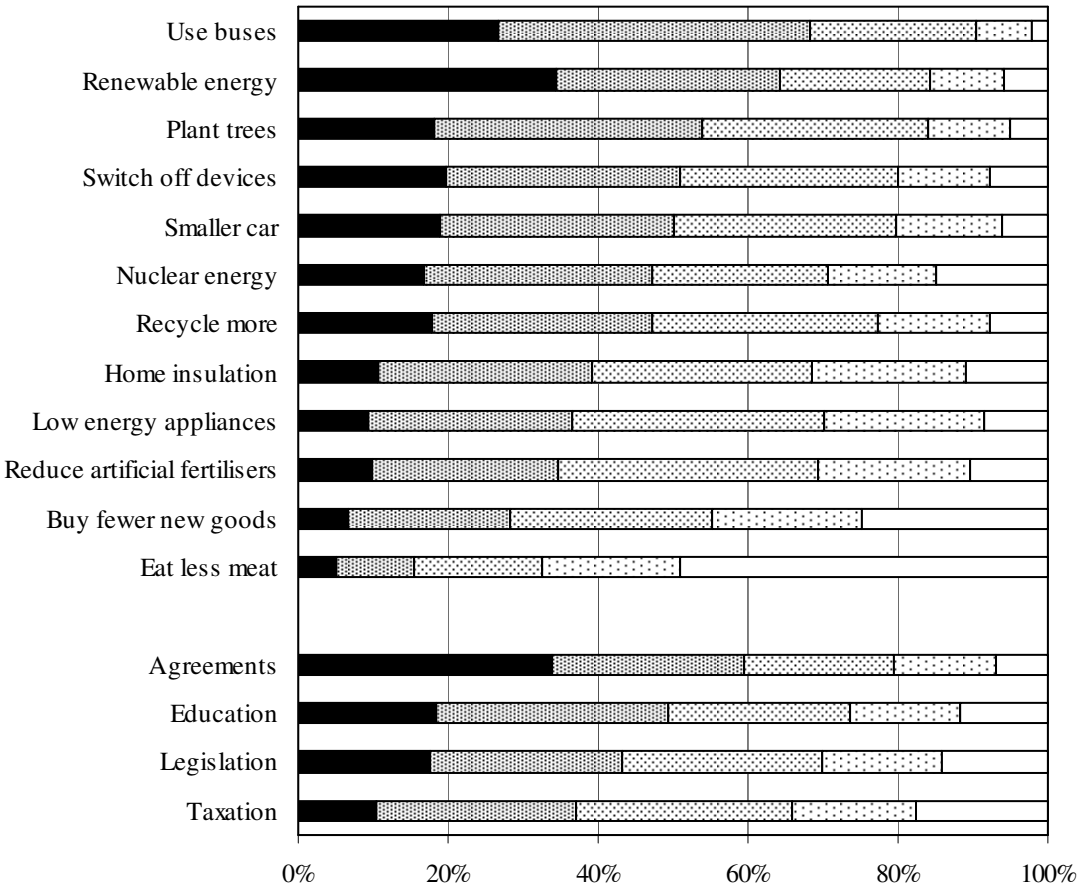
	Degree of Willingness to Act	*Believed Usefulness of Action*	*Potential Effectiveness of Education*	*Natural Willingness to Act*	*Natural Reluctance to Act*	*Potential Usefulness of Education*
	(% 'definitely' + 'almost certainly')	(% 'quite a lot' + 'a fair amount')	(Slope of *Degree of Willingness to Act* plotted vv *Believed Usefulness of Action*)	(Intercept when *Believed Usefulness of Action* is at minimum)	(Measurement between unity and the intercept when *Believed Usefulness of Action* is at maximum)	(*Potential Effectiveness of Education x* proportion of 'perhaps do it' and 'probably not do it')
Direct actions						
Smaller cars	20	50	0.17	0.29	0.54	0.09
Nuclear energy	10	47	0.15	0.20	0.64	0.10
Home insulation	49	39	0.25	0.46	0.28	0.06
Switch off unused devices	68	51	0.14	0.63	0.23	0.02
Plant trees	39	54	0.26	0.36	0.38	0.09
Recycle more	48	47	0.34	0.39	0.27	0.09
Reduce artificial fertilisers	28	35	0.27	0.31	0.42	0.12
Buy fewer new goods	15	28	0.15	0.23	0.62	0.09
Renewable energy	23	64	0.23	0.24	0.54	0.11
Use buses	19	68	0.18	0.19	0.63	0.11
Eat less meat	21	16	0.23	0.27	0.50	0.14
Low energy appliances	44	37	0.25	0.44	0.31	0.07
Indirect actions						
Legislation	21	43	0.23	0.24	0.54	0.13
Taxation	16	37	0.25	0.16	0.59	0.17
Agreements	21	59	0.24	0.23	0.54	0.13
Education	23	49	0.22	0.27	0.52	0.11

Figure 6 Secondary students' *Degree of Willingness to Act* to undertake different pro-environmental actions



For each action, the darkest bar, to the left hand side, represents the percentages of students who would 'definitely' undertake the action; the next, slightly lighter bar those who would 'almost certainly' undertake the action; the next, lighter bar, those who would 'probably' undertake the action; the next bar those who would 'perhaps' take the action; and the right hand, white bar, those who 'probably not' undertake the action. 'Direct' actions are in the upper section of the figure; 'indirect' actions are in the lower section. Within each section, actions are arranged in descending order of the combined percentages of students who would 'definitely' and 'almost certainly' take the action.

Figure 7 Secondary students' *Believed Usefulness of Action* of different pro-environmental actions



For each action, the darkest bar, to the left hand side, represents the percentages of students who responded that the action would reduce global warming by 'quite a lot'; the next, slightly lighter bar those who believe it would reduce global warming by 'a fair amount'; the next, lighter bar, those who believe it would reduce global warming by a 'small but useful amount'; the next bar those who believe it would reduce global warming by 'a very small, hardly noticeable, amount'; and the right hand, white bar, those who believe the action would reduce global warming by 'nothing at all'. 'Direct' actions are in the upper section of the figure; 'indirect' actions are in the lower section. Within each section, actions are arranged in descending order of the combined percentages of students who responded that the action would reduce global warming by 'quite a lot' and by 'a fair amount'.

Figure 8 Comparison of derived indices, *Natural Willingness to Act* and *Potential Effectiveness of Education* for two groups of students, those who are more or less concerned about global warming. The indices and categories are defined in the text.

	Natural Willingness to Act			*Potential Effectiveness of Education*		
Issue	More Concerned	Less Concerned	Sig	More Concerned	Less Concerned	Sig
Direct actions						
Smaller cars	**.40**	**.25**	**	.11	.12	
Nuclear energy	.22	.21		.18	.10	
Home insulation	**.54**	**.44**	*	.20	.23	
Switch off unused devices	**.75**	**.60**	**	.05	.09	
Plant trees	**.50**	**.30**	***	.18	.22	
Recycle more	**.51**	**.36**	**	.28	.28	
Reduce artificial fertilisers	**.41**	**.28**	**	.23	.20	
Buy fewer new goods	**.32**	**.19**	***	.10	.13	
Renewable energy	**.38**	**.18**	***	.14	.21	
Use buses	**.37**	**.15**	**	.07	.11	
Eat less meat	**.38**	**.20**	***	**.11**	**.28**	*
Low energy appliances	**.54**	**.41**	**	.18	.22	
Indirect actions						
Legislation	**.35**	**.21**	***	.20	.10	
Taxation	**.25**	**.13**	**	**.25**	**.11**	*
Agreements	**.32**	**.19**	**	.22	.16	
Education	**.42**	**.21**	***	.13	.15	

*** p<0.001 ** p<0.01 * p<0.05