Undergraduate Understanding of Anthropogenic Climate Change: How Faculty Influences Students' Willingness to Act

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Understanding how a students' willingness to act against anthropogenic climate change (ACC) as influenced by their field of study could help universities produce leaders willing to combat ACC. Previous studies seem to neglect the mediating role that attitude and knowledge of ACC play in the relationship between students' faculty and willingness to act. Addressing this gap in the literature, I argue that there is a relationship between a student's faculty and their willingness to act against ACC (H1) and that the relationship between a student's faculty and their willingness to act against ACC is mediated by a student's attitude and their knowledge of ACC (H2). I carried out an exploratory quota survey that recorded and measured undergraduate students' faculty, attitude, knowledge and willingness to act against ACC at the University of British Columbia, in Vancouver. The survey data were analyzed using ANOVAs and a mediation model that tested the role played by attitude and knowledge in the relationship between faculty and willingness to act. Significant differences between students' from different faculties was found for willingness to act against ACC. Additionally, the mediation analysis shows that students' attitude plays a mediating role in the relationship between willingness to act and faculty but knowledge does not. Although the results are tentative, this study highlights the need for further projects that examine how students' field of study impacts their willingness to act against anthropogenic climate change.

INTRODUCTION

Anthropogenic, or human induced, climate change (ACC) is estimated to cause the death of 302 000 people, negatively impact[1] 238 million

[1]Negative impacts include people affected by (1) weather-related disasters attributed to climate change (e.g.

people and cause 125 billion US dollars in economic loss per annum (Annan, Desai, Egeland, Huq, Merkl, Pachauri, Rockstrom, Sachs, Stocking, Topfer, Wahlstrom, & Fust, 2009, p. 90, 92). This is projected to rise to nearly 500 000 deaths, 310 million people impacted and a cost of 340 billion US dollars by the year 2030 (p. 90, 92). Despite socio-economic and environmental costs of ACC, a lack of political will has resulted in a failure to substantively address the major cause of ACC – the combustion of fossil fuels and the resulting greenhouse gas emissions (GHG) (Allen, Barros, Broome, Cramer, Christ, Church & Van Ypersele, 2014). Limiting the negative impacts of ACC requires a societal shift from dilatoriness to willingness to reduce fossil fuel consumption and the associated GHG emissions. Institutions of higher education can play an important role as an agent of change in guiding societal transformations that address sustainability challenges such as ACC (Stephens, Hernandez, Roman, Graham, & Scholz, 2008, p. 332). Specifically, universities can shape attitudes (Guimond, 1999; Weidman, 1979) and convey knowledge to students, which can influence their willingness to act against ACC (Kuhlemeier, Van Den Bergh & Lagerweij, 1999). However, the field of study taught at universities varies depending on faculty (e.g. Applied Sciences versus Arts versus Sciences) which shapes the type of knowledge conveyed or the attitude internalized by students. Therefore, this paper investigates how undergraduate students' faculty influences their willingness to act. Additionally, the paper examines the role that attitude and knowledge towards/of ACC plays in mediating the relationship between a students' faculty and their willingness to act against ACC. Overall, this paper aims to contribute to the understanding of how higher education prepares undergraduate students, potential future technical and political leaders, to willingly address the defining social and environmental challenge of their generation: anthropogenic climate change.

Many studies have attempted to explore what makes citizens more or less willing to act against ACC or engage in environmentally responsible behaviour (ERB)[2] (Fortner, Lee, Corney, Romanello, Bonnell, Luthy, Figuerido & Ntsiko, 2000; Kuhlemeier et al., 1999; O'Conner, Bord & Fisher, 1999). However, there is no consensus as to why citizens are more or less willing to act against ACC or choose to engage in ERB (Kollmuss & Agyeman, 2002). Few studies focus on specific population groups (Spellman, Field & Sinclair, 2003) in which elucidating the mechanism behind willingness to act may be less complicated. Examining the differences in willingness to act in a specific

droughts) that require emergency aid and (2) gradual environmental degradation related to climate change (e.g. sea level) that are temporarily or permanently harmed because of impacts such as poverty, conflict, or hunger. For more information about how these estimates were determined see Annan et al. (2009).

[2] This paper investigates willingness to act as an independent variable, instead of ERB, as many actions relating to ACC are currently not an option for citizens (e.g. vote 'yes' on a ballot issue to reduce greenhouse gas emissions).

population, such as university undergraduate students, allows one to assess how 'field of study' (e.g. Science, Arts, Applied Sciences) could impact a students' willingness to act against ACC. Previous research exploring willingness to act do not typically examine how the variable changes with education type (Fortner et al., 2000; Kuhlemeier et al., 1999; O'Conner, Bord, & Fisher, 1999). However, Fusco, Snider, and Luo (2012) investigated how education type influences environmentally responsible behaviour (ERB). The study shows that student major is a significant predicator of whether students engaged in ERB or not. Specifically, students majoring in environmental studies (EVS) reported significantly higher levels of ERB than non-EVS majors. These findings suggest that field of study is important in ERB and may be extended to willingness to act against climate change at an education level of faculty rather than major.

Cech (2013) explored how interest in public welfare (e.g. impacts of ACC) changed over time in students from the faculty of applied sciences. Applied Science students from four different universities showed a decline in interest in public welfare over the course of their degree. Cech (2013) suggests that this is a result of the cultural disengagement of Applied Science programs towards issues such as the impact of technology on society. This supports the argument that students from the faculty of Applied Science may be less willing to act against ACC compared to other faculties. This is assuming that other faculties do not see the same decrease of interest in public affairs. The findings of Fusco, Snider, and Luo (2012) and Cech (2013) support the hypothesis that a students' faculty is related to their willingness to act against ACC. Fusco, Snider, and Luo, (2012) attribute the differences between student major (independent variable) reports of ERB (dependent variable) to the mediating role that a students' perception of ACC (mediating variable) plays. Conceptually, a similar dynamic may exist between a student's faculty (independent variable), their attitude/knowledge towards/of ACC (mediating variable), and their willingness to act against ACC (dependent variable). However, previous studies have not explored the possible mediating influence of knowledge and/or attitude in this relationship. This is despite research indicating positive relationships between knowledge/attitude and willingness to act against ACC (Kuhlemeir et al., 1999).

Many government and environmental organizations seek to increase the public's willingness to act against ACC by increasing their knowledge of ACC. Knowledge about ACC is seen by many government and environmental organizations as guiding the public towards increasing their willingness to act against ACC (Bostrom, Morgan, Fischhoff, & Read, 1994; Spellman, Kenfield & Sinclair, 2010). This stems from the concept of an 'information deficit' which identifies a general lack of public knowledge as a deterrent

to constructive support for climate change policy initiatives (Bulkeley, 2000, p. 313). A similar deficit may exist among university students not in faculties specifically focussing on ACC, although public basic knowledge regarding ACC has grown (Reynolds, Bostrom, Read, & Morgan, 2010, p. 1520). This type of cursory knowledge does not appear to have garnered political will to support significant climate change action and may not be sufficient to influence a students' willingness to act. Sterman and Sweeny (2007, p.213) argue that although many people know details about ACC even highly educated MIT graduate students fail to understand some of the basic concepts necessary to substantively address the issue of climate change.[3] These misconceptions regarding climate change mechanisms could lead the general public as well as university students to misinterpret the necessity to act. Research by Kuhlemeir et al. (1999) supports a positive relationship between knowledge and willingness to act, although the relationship was weak and did not account for differences in field of study. However, the study does examine the relationship between attitude towards ACC and willingness to act, finding a strong positive relationship between the two variables. Further supporting the hypothesis that knowledge is not the primary variable that influences willingness to act against ACC are the polls that demonstrate that many North Americans are moderately knowledgeable about climate change but are unwilling to act (Leiserowitz, 2006). Bostrom et al. (1994, p. 968) proposed that mental models, or a set of attitudes, could explain how people view the issue of climate change. Universities' ability to shape attitudes (Guimond, 1999; Weidman, 1979) could play a role in whether students' attitude towards ACC was concerned or dismissive. For example, the research by Cech (2013) suggests that Applied Science students concerned attitudes towards ACC erode through the course of their degree which could be entirely different in other faculties. This decline in concerned attitudes towards ACC is attributed to an emphasis on technical skills over cultural understanding of ethical and social issues. However, generally, there is a paucity of information regarding the potential mediating role played by attitude and knowledge between a students' faculty and their willingness to address ACC.

Overall, this paper will explore how students' willingness to act against climate change is impacted by the 'field of study' they receive. Students' knowledge and/or attitude towards ACC may play mediating role between faculty and willingness to act against ACC. Exploring the relationship between a students' faculty and their attitude, knowledge and willingness to

[3] For example, MIT graduate students seemed to believe that green house gas emissions (GHGs) could be stabilized even if GHG emissions into the atmosphere exceed the amount of GHG being removed (this is similar to a bath tub staying the same level even though the rate of flow into the tub exceeds the rate of drainage out of it) (Sterman and Sweeny, 2007, p.213)

act against ACC this project will show which faculties do not produce students willing to act against ACC. To summarize, I propose the following hypotheses:

> **H1:** There is a relationship between a student's faculty and their willingness to act against ACC
>
> **H2:** The relationship between a student's faculty and their willingness to act against ACC is mediated by a student's (2.1) attitude towards ACC and (2.2) knowledge of ACC

METHODOLOGY

Procedures and Participants

A study of undergraduate student knowledge, attitude and willingness to act against ACC was carried out at the University of British Columbia (UBC). A non-probability quota sampling technique was applied as a result of budgetary constraints. The sample was obtained by selecting at least 25 students from the UBC faculties of Applied Sciences, Sciences and Arts. The 28 question survey was conducted via fluid surveys, an online survey tool, over a three day period (March 26-28, 2014). A social networking site, Facebook, was used to distribute a link to the survey on Applied Sciences, Sciences and Arts UBC group pages. Additionally, the authors' own Facebook contacts, from UBC, were sent a link to the survey through Facebook private messaging service. 75 responses were obtained online. However, this did not fulfill the quota of 25 students from the faculty of Arts, therefore 13 more responses were elicited by distributing hardcopies of the survey in a faculty of Arts class on April 1st, 2014 (Third year Sociology class). The in-class response rate was over 90%. All 88 respondents completed the demographics section and their major characteristics are recorded in Table 1. The majority of the respondents were female, in their third year and were on average 21 years old. The similarity between the number of respondents from the faculties of Science (35.2%), Arts (31.8%), and Applied Sciences (33) reflected the data collection method of quota sampling.

Table 1
Demographics (n = 88)

Characteristic	Summary Statistics
Gender	60.2% female; 39.8% male;
Year level	median - 3rd year
Age	mean - 21; SD - 1.88

Faculty*	35.2% Science; 31.8% Arts; 33% Applied Sciences

* Faculty - for the purpose of this study the five "other" responses, four in commerce, and one in Kinesiology were recoded into Arts and Sciences respectively as these faculties were the most similar of the three core faculties measured in this survey.

Measures

This section outlines the dependent, independent and control variables used in this study. Table 2 shows descriptives for the dependent and independent variables divided by faculty. These descriptives include the means, standard deviations, and ranges for each variable by faculty (and total).

Dependent variables

Climate change knowledge. Knowledge of concepts necessary to understand climate change is assessed by adapting scales developed by Spellman, Kenfield and Sinclair (2010, Items 2-9), and Reynolds, Bostrom, Read and Morgan (2010, Item 1). Response categories included (1) "true", (2) "false", and (3) "don't know". The "don't know" category is incorporated to reduce random guessing. The scale includes the following nine items (correct answer in parenthesis): (1) "Weather means average climate" (False), (2) " Carbon dioxide in the atmosphere contributes to the global greenhouse effect" (True), (3) "Clearing of tropical rainforests is likely to intensify the global greenhouse effect" (True), (4) "A more intense greenhouse effect would probably lead to global warming" (True), (5) "Recent observations strongly suggest that violent volcanic eruptions have no effect on global climate" (False), (6) "Scientists predict that the burning of fossil fuels, especially coal, will enhance the greenhouse effect" (True), (7) "If global warming occurs, it will probably have little, if any, impact on crop and timber production in North America" (False), (8) "When climate changes, it changes in the same way (warmer/drier, for example) everywhere on the planet" (False), and (9) "Without clouds and water vapor in the atmosphere, the planet's surface would be considerably cooler" (True). Item 1 was included to ensure that subjects knew the difference between climate and weather as both Bostrom et al. (1994) and Reynolds et al. (2010) report that many North Americans do not understand what 'climate' in the phrase 'climate change' means.

The scale is summed with each correct response given a value of "+1", incorrect and "don't know" responses were given a value of "0".Correct answers for each item ranged from 34% (K9) to 94% (K8).

Attitude towards climate change. Attitude is measured using a metric designed by Dijkstra and Goedhart (2012). The scale included the following 6 items: (1) "People

should care more about climate change", (2) "Climate change should be given top priority", (3) "It is annoying to see people do nothing for the climate change problems", (4) "People worry too much about climate change", (5) "The seriousness of climate change has been exaggerated", and (6) "Climate change is a threat to the world". Response categories included a 5-point Likert scale of (1) "strongly disagree", (2) "disagree", (3) "neutral", (4) "agree", and (5) "strongly agree".

Question (4) and (5) were reverse coded. The scale was calculated by finding the mean of the 6 items to create an 'Attitude Index' ($\alpha = 0.86$).

Faculty. Participants are asked "Which faculty are you from?" Response categories include (1) "Science", (2) "Arts", (3) " Applied Science (engineering)", and (4) "Other".

Independent variables

Willingness to act against climate change. Willingness to act against climate change is assessed by adapting Fortner et al.'s (2010) measure to better reflect potential actions of undergraduate students. Subjects were asked "How willing are you to" for the following 9 statements: (1) "Use public transportation more than you do now", (2) "Install low-energy light bulbs in your house", (3) "Support an increase in gasoline prices", (4) "Support lawsuits against emitters of greenhouse gases", (5) "Vote 'yes' on a ballot issue to reduce greenhouse gas emissions", (6) " Eat more food grown locally ", (7) " Attend demonstrations supporting environmental causes ", (8) "Support environmental education in schools", and (9) "Use less air conditioning in the summer and less heat in the winter". Response categories included a 5-point Likert scale of (1) "very unwilling", (2) "unwilling", (3) "neutral", (4) "willing", and (5) "very willing". The 9 items were summed to construct a 'Willingness Index' ($\alpha = 0.82$).

Control variables

Gender. The subjects were asked "What gender are you?" The response categories include (1) "male" and (2) "female".

Age. The subjects were asked "How old are you?" The subjects were given a space to enter their age.

Year level. Subjects were asked "What year are you in?" The response categories are (1) "First year", (2) "Second year", (3) "Third year", (4) "Fourth year", (5) "Fifth year and above" and (6) "Recently graduated".

Data Analysis

IBM SPSS Statistics 20 was used to process and analyse the data. Initially,

data was cleaned, recoded into larger variables, and reverse coded where necessary. Missing data was corrected for and larger variables were recalculated. For the purpose of regression analysis the nominal variable, faculty, was recoded into three binaries of applied Sciences and non-Applied Sciences, Sciences and non-Sciences, and Arts and non-Arts students. The faculty of Arts was left out of the analysis as a dummy variable. Hypotheses testing was carried out through the use of ANOVAs for H1, and a step-wise regression analysis for H2. Mediation was evaluated by assessing whether the three criterion for mediation, described by Judd and Kenny (1981) and summarized by MacKinnon, Krull and Lockwood (2000), were met. These three criteria are (a) a significant relationship between the independent variable (IV) and the dependent variable (DV), (b) a significant relationship between the IV and the mediating variable (MV), and (c) that the MV is a significant predicator of the DV when both the MV and the IV are accounted for in the same equation.

Results

The first hypothesis is that **(1) there is a relationship between a students' faculty and their willingness to act against climate change.** The nominal independent variable, faculty, is related to the interval dependent variable, willingness to act. A one-way ANOVA shows that between faculties there is a difference in willingness to act at a significance level of 0.01 (F= 8.0, df = 2) (Table 2). Additionally, Table 2 shows significant differences between the three faculties (Sciences, Arts, and Applied Sciences) for knowledge and attitude.

Table 2
Dependent and independent variable descriptives by faculty (n = 88)

	Sciences (31) Mean (SD)	Arts (28) Mean (SD)	Applied Sci. (29) Mean (SD)	One-way ANOVA F-value (Sig.)
Willingness to act	0.85 (0.90)	0.77 (0.11)	0.73 (0.15)	8.03 (.001**)
Knowledge	0.79 (0.20)	0.65 (0.19)	0.73 (0.20)	3.87 (.025*)
Attitude	0.89 (0.09)	0.76 (0.14)	0.74 (0.20)	8.82 (.000**)

Note - All variables assumed normally distributed with kurtosis and skewness either between 1 & -1 or within +/-0.2

* p-value < 0.05, ** p-value < 0.01

The second hypothesis was that **(2) the relationship between a student's faculty (independent variable) and their willingness to act against ACC (dependent variable) is mediated by a student's attitude and knowledge of ACC (mediat-**

ing variables). Judd and Kenny's (1981) three criteria for mediation were applied to test H2. Criteria (a) is met as there is a significant relationship between willingness to act (DV)and faculty (IV) (see H1). Criteria (b) is met as there is a significant relationship between faculty (IV) and both attitude ($p < 0.01$) and knowledge ($p < 0.05$) (MVs) (Table 2).

Criteria (c) is evaluated through a step-wise regression analysis model (Table 3). The regression analysis applied shows how independent variables can reduce the error in prediction of the dependent variable, when accounting for the other independent and control variables of this survey. The first model supports criteria (a) that the dependent variable, willingness to act, is significantly related to the independent variable, faculty (Sciences and Applied Sciences), with a beta coefficient for Sciences of 0.30 ($p < 0.05$) and Applied Sciences of -0.15 (not significant). This means that compared to Arts students, Science students are more willing to act, whereas there is no difference in willingness to act between Arts and Applied Science students. The second model controls for variables such as gender and year level. However, including these controls does not change the significance level of the relationship between Sciences (faculty) and willingness to act with a significant beta coefficient of 0.29 ($p < 0.05$). Including these control variables increased explained variance, or R squared value, by 0.005. The final model (model 3) included the mediating variables of knowledge and attitude. Knowledge has a beta coefficient of 0.03 and does not have a significant relationship with willingness to act. Therefore, knowledge as a mediating variable does not meet criteria (c). Attitude has a significant beta coefficient of 0.72 ($p < 0.01$) thereby meeting criteria (c). Including attitude and knowledge reduced the beta coefficient of Science (faculty) to 0.00 (Table 3) and also made it not significant. Overall, model 3 explained 56% of the variance compared to model 1 and 2 which explained 12% and 14% respectively. All three models had significant F-values for the relationship between the IVs and the DV ($p < 0.01$). The mediation analysis demonstrates that the reason Science students are more willing to act is because they have, for whatever reason, developed attitudes supportive of action. Whether those attitudes developed during their university studies or preceded their entry into Science is unknown.

Table 3
Beta coefficients for step-wise regression analysis on the relationship between willingness to act and possible independent, control and mediating variables (n = 88)

	Model 1	Model 2	Model 3
Independent Variables			

Sciences (faculty)	.30* (2.57)	.29* (2.50)	.00 (.04)
Applied Sciences (faculty)	- .15 (- 1.29)	- .12 (- 0.96)	- .06 (- .70)
Control Variables			
Gender	-	.06 (.59)	.12 (1.57)
Year Level	-	.05 (.47)	.08 (1.01)
Mediating variables			
Knowledge	-	-	.03 (.435)
Attitude	-	-	.72** (9.00)
R squared	.16	.16	.59
Adjusted R squared	.14	.12	.56
F statistic	8.031 87 df	4.059 87 df	19.655 87 df
p-value	<0.001	<0.005	<0.001

Notes: (1) t-values in parentheses (2) Faculty of Arts left out as a dummy variable

* p-value < 0.05, ** p-value < 0.01

DISCUSSION

Conclusions

(1) The results show a relationship between what faculty a student is in and their willingness to act against climate change. The reported R squared value was 0.16 (Table 3) indicating that knowing what faculty a student was from could reduce the error in predicting their willingness to act by a factor of 0.159, which means the relationship is relatively weak. There is a lack of literature around how different forms of education impacts willingness to act against climate change measurements. However, this survey indicates that field of study may play a role in how willing a UBC undergraduate, a potential future leader, would be to combat climate change.

(2) The results suggest that attitude mediates the relationship between faculty and willingness to act, but knowledge does not. The stronger and significant relationship found between attitude and willingness to act compared to knowledge and willingness to act is supported by previous literature (Kuhlemeier, 1999). This may explain why the results show mediation between faculty and willingness to act for attitude but not knowledge. This is supported by the relatively high Beta coeffi-

cient of attitude, 0.72 ($p < 0.01$), compared to all the other low Beta values for the independent and control variables. The Beta coefficients show that the control variables of gender and year level is not significantly related to willingness to act. This is despite previous literature documenting gender as a variable of interest when exploring issues such as climate change knowledge, impact and discourse (McCright, 2010; Denton, 2010; Arora-Jonsson, 2011). The exploratory nature of this project may explain this difference on gender, or perhaps gender is less important when investigating the relationship between faculty and willingness to act then previous literature would suggest. When all independent and control variables (attitude, knowledge, faculty, gender and age) were accounted for an R2 value of 0.59, suggested that they were together a strong indicator for the dependent variable; given that using these variables one could reduce the error in prediction of willingness to act by 0.59 (See Table 3, Model 3). However, attitude remains the dominant contributor explaining this relationship. Attitude's mediating role between willingness to act and faculty suggests that either different faculties attract students with different attitudes towards ACC or different faculties shape students attitudes differently. The latter seems to be supported by research by Cech (2013) where Applied Sciences students' attitude towards socio-economic issues declined over time with their interest in related topics such as technology's impact on society. Overall, these conclusions provide an exploratory view of how students' field of study can play a role in willingness to act against climate change and how this relationship could be mediated by attitude.

LIMITATIONS

The gathering of the data limits the conclusions that can be drawn from the results as the study made use of non-probability quota sampling. This may have biased the results although the extent of such bias, if there is any, is unknown. One particular bias may be that Science students were likely to come from Environmental Science, a group more motivated to complete the survey. This would not be an accurate reflection of students in the faculty of Sciences. Therefore, the results of the survey may not provide an accurate representation of the study population. Another issue with the survey design is that the study was limited to one university and therefore the findings may not reflect other university student populations. Apart from survey design, the study is limited as the data was self-reported and therefore may not reflect actual student attitude, and/or willingness to act against climate change. In addition, for the internet survey a response rate was not calculated.

RESEARCH IMPLICATIONS

The main findings of this project suggest that the field of study (different faculties) play a role in a students' willingness to act against anthropogenic cli-

mate change. However, as a result of the exploratory nature of the project design and data collection, all findings are tentative. The literature review also showed that there is a dearth of academic literature regarding undergraduate students and their relationships with attitude and knowledge with willingness to act against climate change. This needs to change and more statistically powerful studies (sample size and representativeness) should be completed to explore these relationships fully. Specifically, the mediating role played by attitude in the relationship between student's faculty and their willingness to act should be further explored. A longitudinal study such as (Cech, 2013) would offer more meaningful results as one could differentiate between faculties attracting students with certain attitudes or faculties actually changing student attitudes. Overall, it is essential that more studies are completed on university students about anthropogenic climate change so as to inform educators on where change has to happen if universities are going to produce political and technical leaders that are willing to act against anthropogenic climate change.

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APPENDIX

Correlation table between independent and dependent variables

Table 4, shows the correlations between all interval and ratio, independent and dependent variables used in this analysis. The Pearson correlation shows the strength of the relationship between the two variables and whether or not the correlation is significant. Attitude (0.75) had a higher Pearson correlation with the independent

variable, willingness to act, compared to knowledge (0.22). Both dependent variables are significantly correlated with the independent variable, willingness to act.

Table 4
Pearson correlation table between dependent and independent variables (n = 88)

	Willingness	Knowledge	Attitude
Willingness to act	1	-	-
Knowledge	.22*	1	-
Attitude	.75**	.23	1

* Correlation is significant at the 0.05 level

** Correlation is significant at the 0.01 level

Scatterplots

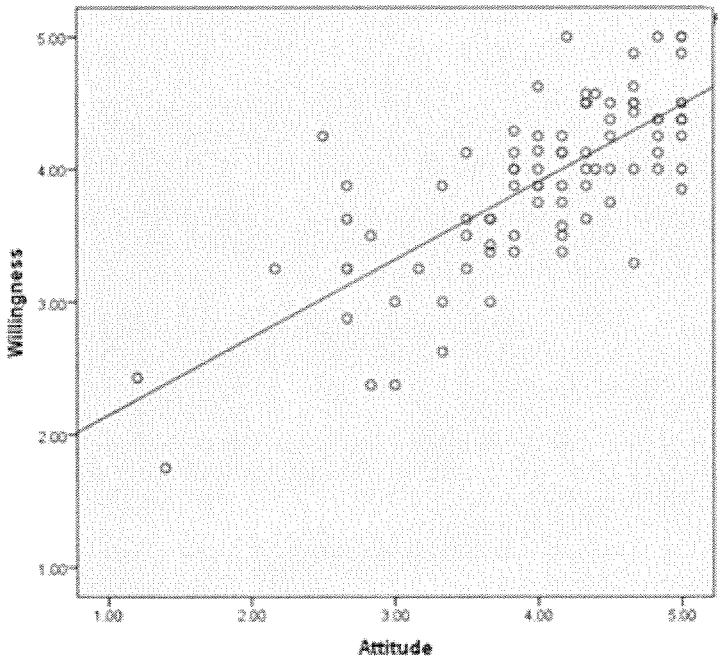

Figure 1: Shows a strong positive relationship between attitude and willingness to act.
The R2 value is 0.56 and significant at a level of 0.01.

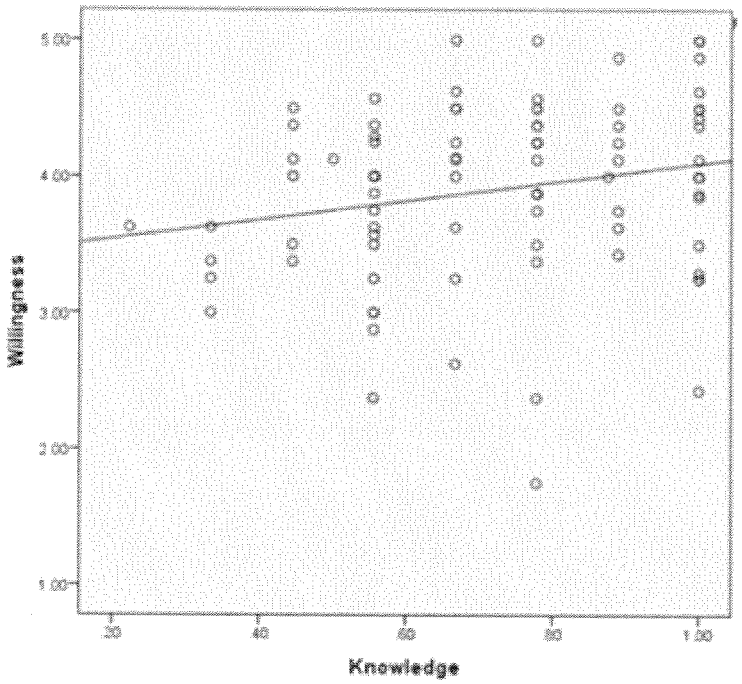

Figure 2: Shows a weak positive relationship between knowledge and willingness to act.

The R2 value is 0.049 and significant at a level of 0.05.