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# The Climate Change Attitude Survey: Measuring Middle School Student Beliefs and Intentions to Enact Positive Environmental Change

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The Climate Change Attitude Survey is composed of 15 Likert-type attitudinal items selected to measure students' beliefs and intentions toward the environment with a focus on climate change. This paper describes the development of the instrument and psychometric performance characteristics including reliability and validity. Data were gathered from 1576 middle school students from across the United States in 2014 to validate the instrument and establish the measurement properties of the instrument's scales. Factor analysis revealed two stable constructs representing beliefs and intentions, which were reconfirmed through multidimensional scaling and hierarchical cluster analysis techniques. Internal consistency reliability was found to be respectable for the survey as a whole as well as the two separate scales. The Climate Change Attitude Survey was created to fill a void in the measurement of middle school students' affective responses to the environment and climate change. Educators may find this survey useful for assessing pre- to post intervention attitude changes as well as for identifying differences in selected groups of students. Further development is targeted to include adding new constructs as well as testing the instrument with different population subgroups.

*Keywords*: environment, middle school students, climate change, survey instrument

## INTRODUCTION

While a large percentage (63%) of American adults report they believe in the existence of climate change, very few (14%) say they are "very worried" about it (Leiserowitz, Maibach, Roser-Renouf, Feinberg & Howe, 2013). Those surveyed see climate change as a distant threat that will impact future generations (Leiserowitz et al., 2013). Americans were shown to be more skeptical than people in other countries (Carlsson et al., 2010; Infographic, 2011). A European study of 27 member

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states of the European Union revealed an overall belief that climate change is a serious issue with EU states varying a great deal from 32% to 82% (European Commission, 2009). Researchers have pointed to a lack of curriculum content regarding climate change in schools (Choi, Niyogi, Shepardson, & Charusombat, 2010) leading to students receiving more of their information from the media than teachers (Robertson & Barbosa, 2015). The age-stability theory assumes that adolescents' social and political attitudes are already strongly developed by the time they leave secondary school (Alwin & Krosnick, 1991; Sears & Funk, 1999). Therefore, the development of positive environmental attitudes in childhood is an important element in shaping behaviors in later life (Ballantyne, Connell, & Fien, 2006; Chawla, 1999; Meinhold & Malkus, 2005). Knafo and Galansky (2008) found a positive relationship between learning about the environment at school and the level of environmental concern. Researchers have concluded that educating students about the environment can influence their future behaviors. This article describes the development and validation of a new self-report instrument designed to assess changes in attitudes of middle school students resulting from learning about the ways in which the global climate is changing and probable causes for these changes.

## Conceptual background

The Climate Change Attitude Survey (CCAS) was developed with the goal of providing a tool to not only measure middle school students' attitudes and beliefs about climate change but also their intentions to enact positive change. Measuring students' attitudes toward educational endeavors allows educators to plan appropriate instruction and determine effectiveness in the curriculum. This section addresses conceptual, theoretical and educational underpinnings for the CCAS with an emphasis on climate change beliefs and behavioral intentions.

Environmental education targets affective as well as cognitive outcomes with the intention of developing informed citizens with positive attitudes toward conserving energy (Lawrenz, 1988). Citizens who are knowledgeable about energy-related issues do not necessarily change their behaviors or even intend to change their behaviors in the effort to conserve energy and the environment (DeWaters & Powers, 2013). Knowledge is a precursor to beliefs which may or may not lead to actions. Environmental attitudes consist of beliefs, affect, and behavioral intentions that combine to illustrate attitudes toward environmentally related activities or issues (Schultz, Gouveia, Cameron, Tankha, Schmuck & Franek, 2005; DeWaters & Powers, 2013).

Fortus (2014) published an editorial pointing out the lack of published research during the first decade of the 21st century related to affect in science education. He observed:

> Regardless of whether students will go on to work in a STEM-related profession or just live in a STEM-influenced world, we should strive for all to have positive attitudes to science and its role in society, motivation to understand the science of issues directly related to their lives and their general well-being, and a belief in their ability to make sense of issues (Fortus, 2014, p.822).

Fortus (2014) further contended that very little learning occurs without a desire to learn (motivation, attitudes, beliefs, self-efficacy, interest, self-concept, etc.).

Intentions and beliefs have been recognized as important in science education for decades (Haney, Czeriak, & Lumpe, 1996). In Ajzen's (1985) theory of planned behavior, beliefs are used to predict an individual's intention to engage in behavior. Behavioral intentions have been defined by Ajzen (2002) as indication of an individual's readiness to perform a given behavior, based on attitudinal beliefs and perceived behavioral control, and are assumed to be an immediate predecessor to

behavior. The theory of planned behavior was developed from the Expectancy Value Models (Ajzen & Fishbein, 1980). According to this theory, if people evaluate the suggested behavior as positive (attitude) there is a higher intention (motivation) to perform the behavior. Many studies have confirmed a high correlation of attitudes to behavioral intention and subsequently to behavior (Sheppard, Hartwick, & Warshaw, 1988). One study measuring attitudes toward human-induced climate change found students who have a more accepting attitude toward climate change are more likely to express a willingness to take action (Sinatra, Kardash, Taasoobshirazi, & Lombardi, 2012). The CCAS development was channeled toward the measurement of a) accepting attitudes toward climate change (beliefs) and b) willingness to take actions (intentions) in line with published theories and research-based recommended practice.

## LITERATURE REVIEW

The authors initially conducted a search of existing literature in hopes of finding an instrument to measure middle school students' beliefs and intentions regarding the environment, and specifically climate change. The search revealed few well-validated surveys appropriate for the age level targeted. Many of the surveys that have been used to measure attitudes toward the environment were developed for adults (Weigel & Weigel, 1978; Sinatra et al., 2012; Milfont & Duckitt, 2010). Most of the surveys that are appropriate for middle school students are aimed at general attitudes toward the environment (recycling, deforestation, etc.) (Musser & Malkus, 1994; Yilmaz, Boone, & Andersen, 2004; Metin, 2010; Milfont & Duckitt, 2010; Sarkar, 2011; Dijkstra & Goedhart, 2012; LeHebel, Montpied, & Fontanieu, 2014) while the attitudes the researchers were seeking to evaluate were specific to climate change. As a result, the authors elected to construct a new instrument based on the considerations described in the following paragraphs.

Motivation to act on one's beliefs is an important step in enacting change (Sinatra et al. 2012). One goal of educating students about climate change and human impact on the environment is to create responsible adults who will make informed decisions regarding the environment in the future. One published study employed persuasive text materials with college students to change their attitudes as well as influence their willingness to change regarding global climate issues (Sinatra et al., 2012). Findings suggest that students who have more favorable attitudes toward the idea of human-induced climate change are more likely to report a willingness to take action (Sinatra et al., 2012). Other researchers have found that increasing environmental content knowledge in individuals results in more positive attitudes and responsible behavior toward the environment (Bradley, Waliczek, & Zajicek, 1999; McMillan, Wright & Beazley, 2004) while one multi-national study was unable to show that knowledge about climate change was related to environment-related attitudes (Dijkstra & Goedhart, 2012). A connection between what is learned in science in school and environmental attitudes has been reported (Karpiack & Baril, 2008). The 2006 PISA data also revealed a correlation between student performance in science and their environmental attitudes (Boeve-de-Pauw & Van Petegem, 2010).

The Wisconsin Center for Environmental Education conducted a large-scale study in 1994 focusing on students in grades 5 and 11. The goal of the study was to determine the general level of environmental literacy (Champeau, 1997). A small number of items focused on environmentally responsible behaviors and personal efficacy regarding student impact on the environment. Five of the items from the Wisconsin study were deemed to be potentially useful for measuring middle school students' attitudes toward the environment and specifically climate change. These served as the foundation for the development of a new climate change attitude

survey developed for middle school students to measure students' beliefs and intentions regarding the environment.

### Gender and attitudes toward climate change

While some researchers have reported that female students have more negative attitudes toward science than male students (Dijkstra & Goedhart, 2012) other researchers have found that girls have positive dispositions toward science (if not higher than boys) (Archer, DeWitt, Osborne, Dillon, Willis & Wong, 2012). The discrepancy in findings may be dependent on the type of science in which males and females associate their responses. Results of several studies have suggested that females have more positive attitudes toward environmental issues and are more concerned about the environment than males (Davidson & Freudenburg, 1996; Gardos & Dodd, 1995; Leppanen, Haahla, Lensu & Kuitunen, 2012). Females have also been shown to become more actively involved in protecting the environment (Tosunoglu, 1993). Leppanan et al. (2012) compared students' and parents' environmental attitudes and found that girls were as positive as their parents while boys were noticeably more negative than their parents. A survey that measures both beliefs and intentions regarding climate change may allow researchers to discriminate these constructs by gender.

## INSTRUMENT DEVELOPMENT

### Item selection

A search for instruments related to climate change for middle school students was conducted. While several surveys were found, there were none that focused specifically on climate change for middle school students. Many of the surveys were aimed at more mature populations, (Leiserowitz et al., 2013; Milfont & Duckitt, 2010; Sinatra et al., 2012) were general environmental science or energy surveys (DeWaters, Qaqish, Graham, & Powers, 2013; Metin, 2010; Musser & Malkus, 1994), contained complex (multiple issue) items (Weigel & Weigel, 1978), or were biased in their wording (LeHebel et al., 2014).

Due to the scarcity of existing instruments appropriate for the targeted audience, the authors elected to compile and adapt items to target specific constructs as they had successfully accomplished with attitude instruments in the past (Knezek & Christensen, 1996; Christensen & Knezek, 2002; Christensen & Knezek, 2004; Tyler-Wood, Knezek, & Christensen, 2010; Mills, Wakefield, Najmi, Christensen, & Knezek, 2011). Ten of the items were adapted or developed by the authors based on published literature about survey instruments addressing climate change attitudes in adults (Leiserowitz et al., 2013). The authors adapted items to reflect the ideas and concepts specifically targeted in the Middle Schoolers Out to Save the World (MSOSW) project funded by the U.S. National Science Foundation to encourage teachers and their students to monitor standby (vampire) power in home appliances and produce whole-classroom spreadsheet projections of ways to reduce global CO2 production and help save the world (Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013). As DeVellis (2003) recommends, an attempt was made to create new (or adapt from existing) items to produce unambiguous declarative statements without jargon. Five additional items were added from a survey developed in 1994 by the Wisconsin Center for Environmental Education (Champeau, 1997). The Wisconsin survey contained a subset of items related to student interest in the environment, for students in grades 5 and 11. All 15 items included in the Climate Change Attitude Survey are Likert-type items with rating scales ranging from 1 to 5: 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 =

agree and 5 = strongly agree. Five of the items are negatively worded and should be reversed before combining related items into scales for data analysis. Items selected to measure intentions were modified or selected to take the first person form of wording, in order to elicit *ratings* from the respondents of what they themselves planned to do, while the belief items were modified and/or chosen to elicit judgments (Dunn-Rankin, Knezek, Wallace, & Zhang, 2004) by the respondents of what they think is true in the general public. Middle school science teachers who teach in the funded project as well as university professors in STEM fields also examined survey items and judged these items appropriate for middle school students.

## Data source

The Climate Change Attitude Survey was completed by 1576 middle school students in grades 5 through 8 participating in the Going Green! Middle Schoolers Out to Save the World (MSOSW) project. The middle school students were from 29 different U.S. classrooms selected from eight states including California, Hawaii, Louisiana, Maine, Michigan, North Carolina, Virginia and Texas. While the teachers volunteered to participate in the project, the students are representative samples from the schools they attend, which were themselves selected for their diversity in climate zones, rural versus urban locations, socioeconomic status of their neighborhoods, and public versus private funding status. These data, along with other attitudinal and content data related to STEM and demographic items, were gathered through an online server at the beginning of the 2014-2015 school year as part of the project's pretest data collection for the school year. The MSOSW project is funded by a U.S. National Science Foundation Innovative Experiences for Students and Teachers grant. In the MSOSW project, teachers attend an institute to learn about the energy-related curriculum and how to implement the curriculum with their students. MSOSW teachers also are provided with energy monitors, web enhanced teaching resources, curriculum and ongoing support from the project personnel. The focus of the curriculum and activities are related to standby power, power that is being used by appliances when they are plugged in but serving no useful function. The curriculum also includes estimating the impact that wasted power has on the changing climate in our world.

# ANALYSIS AND RESULTS

## Descriptive statistics

The means, standard deviations and number of participants for individual items for the Climate Change Attitude Survey are shown in Table 1. The respondents most strongly agreed with item 1, "I believe our climate is changing" and least strongly with item 14, "It is a waste of time to work to solve environmental problems."

**Table 1.** Descriptive statistics for all 15 items on the Climate Change Attitude Survey (CCAS)

| | N | Mean | Std. Deviation |
|---|---|---|---|
| **CCAS Item 1** | 1562 | 3.94 | .904 |
| **CCAS Item 2** | 1562 | 3.45 | 1.085 |
| **CCAS Item 3** | 1564 | 3.69 | .931 |
| **CCAS Item 4** | 1560 | 3.47 | 1.012 |
| **CCAS Item 5** | 1563 | 3.70 | .998 |
| **CCAS Item 6** | 1561 | 3.63 | 1.027 |
| **CCAS Item 7** | 1562 | 3.57 | 1.126 |
| **CCAS Item 8** | 1564 | 3.26 | 1.043 |
| **CCAS Item 9** | 1562 | 2.64 | 1.178 |
| **CCAS Item 10** | 1551 | 3.92 | .954 |
| **CCAS Item 11** | 1560 | 3.56 | 1.022 |
| **CCAS Item 12** | 1557 | 2.97 | .974 |
| **CCAS Item 13** | 1561 | 2.66 | 1.056 |
| **CCAS Item 14** | 1560 | 2.03 | 1.031 |
| **CCAS Item 15** | 1552 | 2.52 | 1.087 |

## Instrument reliability

**Table 2.** Strength of individual items on the Climate Change Attitude Survey

| | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|---|---|---|---|---|
| **CCAS Item 1** | 44.99 | 41.348 | .529 | .684 |
| **CCAS Item 2** | 45.49 | 39.985 | .525 | .680 |
| **CCAS Item 3** | 45.25 | 40.386 | .601 | .676 |
| **CCAS Item 4** | 45.47 | 40.216 | .557 | .679 |
| **CCAS Item 5** | 45.23 | 40.058 | .574 | .677 |
| **CCAS Item 6** | 45.30 | 41.396 | .441 | .691 |
| **CCAS Item 7** | 45.36 | 40.539 | .457 | .688 |
| **CCAS Item 8** | 45.67 | 41.561 | .424 | .693 |
| **CCAS Item 9** | 46.31 | 47.387 | -.026 | .747 |
| **CCAS Item 10** | 45.02 | 42.846 | .368 | .700 |
| **CCAS Item 11** | 45.37 | 41.948 | .403 | .696 |
| **CCAS Item 12** | 45.98 | 45.775 | .124 | .725 |
| **CCAS Item 13** | 46.28 | 46.249 | .071 | .732 |
| **CCAS Item 14** | 46.91 | 48.068 | -.054 | .744 |
| **CCAS Item 15** | 46.43 | 46.674 | .035 | .737 |

*Note: Cronbach's Alpha for 15 item survey = .72*

Cronbach's Alpha for the 15-item survey was .72. According to guidelines provided by DeVellis, the internal consistency reliability is considered "respectable." As shown in Table 2, the strength of the survey would be weakened if items 9, 11, 12, 13, 14 or 15 are included in the same overall scale as items 1-8 and 10. This led the researchers to conduct exploratory factor analysis to determine if the survey did indeed have more than one construct included among the set of items.

## INSTRUMENT VALIDATION

Measurement specialists (eg. DeVellis, 2003) refer to reliability (consistency) plus multiple forms of validity (relevance) as being important for a well-constructed survey instrument. While validation of a survey instrument is well known to be an on-going process, researchers generally agree (Benson & Clark, 1982) initial indications of validity can be established throughout the instrument development process. The three common forms of validity are usually referred to as content, construct and criterion-related validity, the latter of which can be established by alignment with expected measures or demonstration of the ability to separate groups. Factor analysis and multidimensional scaling analyses presented in this section will demonstrate the scales of the instrument have acceptable construct validity.

Criterion-related validity addresses whether the scales tend to separate groups that might be expected to differ (such as males and females) or conversely, whether the scale values might tend to correlate with other attributes (such as "wanting to make the world a better place") that might reasonably be expected to align. Analyses of variance and Pearson correlations are techniques commonly used for this type of validation.

### Construct validity: Factor structure

An exploratory factor analysis (principal components analysis, varimax rotation to preserve statistical independence (orthogonality) of derived constructs for future multivariate tests) of the 15 individual items on the survey, using the 1576 responses, indicated that two or three constructs were likely well represented by the items on the CCAS (see scree plot in Figure 1). As shown in Table 3, two factors extracted from the data accounted for 47% of the common variance among the responses. Examination of the three-factor structure initially extracted (Eigenvalues =>1) revealed a very weak third factor. Additional content analysis of the items representing the two and three-factor structures resulted in the judgment that only two viable factors could be extracted. These factors were observed by the researchers to measure beliefs about climate change and intentions related to climate change and the environment. As shown in Table 4, Factor 1 contained 10 items related to perceived beliefs at large about climate change and our environment while Factor 2 contained 5 items related to intentions regarding making a difference in climate change.

**Table 3.** Percent of variance accounted for by factor analysis procedure

| Component | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings |
|---|---|---|---|---|
| | Total | % Variance | Cumulative % | Total |
| 1 | 4.991 | 33.271 | 33.271 | 4.725 |
| 2 | 2.084 | 13.895 | 47.166 | 2.350 |
| 3 | 1.110 | 7.398 | 54.564 | |
| 4 | .889 | 5.927 | 60.491 | |
| 5 | .774 | 5.162 | 65.653 | |
| 6 | .745 | 4.967 | 70.620 | |

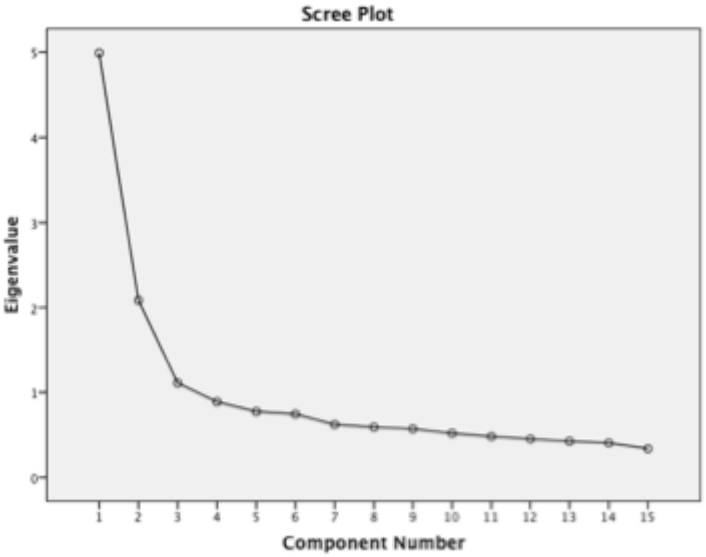


**Figure 1**. Scree plot for 15 inventory items using principal component analysis.

**Table 4.** Factor loadings for two factors emerging from 15 items

| Item | Component | |
|---|---|---|
| | 1 | 2 |
| **CCAS Item 3** | .783 | |
| **CCAS Item 5** | .769 | |
| **CCAS Item 4** | .735 | |
| **CCAS Item 2** | .733 | |
| **CCAS Item 1** | .707 | |
| **CCAS Item 6** | .670 | -.225 |
| **CCAS Item 7** | .669 | -.135 |
| **CCAS Item 11** | .587 | -.132 |
| **CCAS Item 8** | .568 | |
| **CCAS Item 10** | .553 | -.185 |
| **CCAS Item 15** | | .750 |
| **CCAS Item 14** | -.204 | .720 |
| **CCAS Item 13** | | .700 |
| **CCAS Item 9** | -.128 | .586 |
| **CCAS Item 12** | | .547 |

Note: Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.a
a. Rotation converged in 3 iterations.

## Reliability of instrument scales

Once the two factors were determined, SPSS (2010) was used to compute internal consistency reliability estimates for the scales. Cronbach's Alpha was found to be .87 for the ten items loaded most strongly on Factor 1. Cronbach's Alpha was .90 at post test time. Cronbach's Alpha for the five items loaded most strongly on Factor 2 was found to be .70 for this set of middle school participants (Table 8) at pretest time and .78 at post test time. This is in the range of "Very Good" for Factor 1 and "Respectable" for Factor 2 according to the guidelines provided by DeVellis (1991). No weak items were identified based on the examination of the *corrected-item total correlations* resulting if one item were to be pulled out from the scale on its own and correlated with a scale produced from the rest, and the *Alpha if item deleted*.

## Relationships among items in scales

The Multidimensional scaling (MDS) procedure PROXSCAL (SPSS, 2010) was used to help determine the minimum number of constructs that would adequately represent the 15 items. As shown in Figure 2, a two-dimensional MDS solution places the items as objects in relation to each other in a fashion congruent to the accepted factor analysis solution. However, additional perspectives are added regarding the relationships within and among the items based on physical placement in the MDS two-dimensional solution in Figure 2. For example, item 9 (We cannot do anything to stop global climate change) and item 12 (I think most of the concerns about environmental problems have been exaggerated) are on the left side of the Y-Axis in Figure 2, as are all other items loading strongly on component 2 in Table 4. However the close proximity of the two to each other can also warrant calling these two a cluster of their own and helping establish the social distance groupings of the items, as discussed in the following paragraph of this paper. The total dispersion accounted for (D.A.F.) in the two-dimensional solution is .98288, indicating that almost all of the distances between the items as objects can be accounted for by placing the scales in the two-dimensional orientation shown in Figure 2. The one-dimensional solution produced by multidimensional scaling analysis (MDS) for the 15 items in this study is shown in Figure 3. This solution places the ten items in Factor 1 together at one end of the model and the five items on Factor 2 at the other end, showing a separation between the two factors. The total dispersion accounted for (D.A.F.) is .96104, just slightly less than the two-dimensional solution.

The one-dimensional solution is consistent with placing items along the continuum of "close to me" or "far away from me" for climate change as an issue while the two-dimensional solution identifies categories potentially representing distances removed from taking action. For example, a person strongly agreeing with items 9 and 12 (quadrant IV) is unlikely to take any positive action while an individual strongly agreeing with items such as 10 (quadrant I) are poised to immediately take action. Based on a content analysis of the items within the clusters, the researchers have tentatively identified the clusters in the four quadrants of Figure 2 as:

Category 4 Indicators – Don't believe; no need to try – Items 9, 12

Category 3 Indicators – I can't change anything – Items 13,14,15

Category 2 Indicators – Accept responsibility for the environment – Items 2,4,5,6,7,8

Category 1 Indicators – Ready to take action – Items 1,3,10,11

A hierarchical cluster analysis (between groups linkage, squared Euclidean distance) (SPSS, 2010) was carried out on the 15 items from the survey in order to

further explore the relationships among items. Major clusters closely correspond to the factors identified through exploratory factor analysis in Table 4 and the two-dimensional structure identified through multidimensional scaling shown in Figure 3. As indicated in Figure 4, the major cluster of items 9,12,13,14,15 (Factor 2 in Table 4) is separated at the highest level from the other cluster of items, which correspond to Factor 1 in Table 4. The cluster analysis also indicates that items 1 and 3 are the most strongly related to each other as are items 4 and 5.

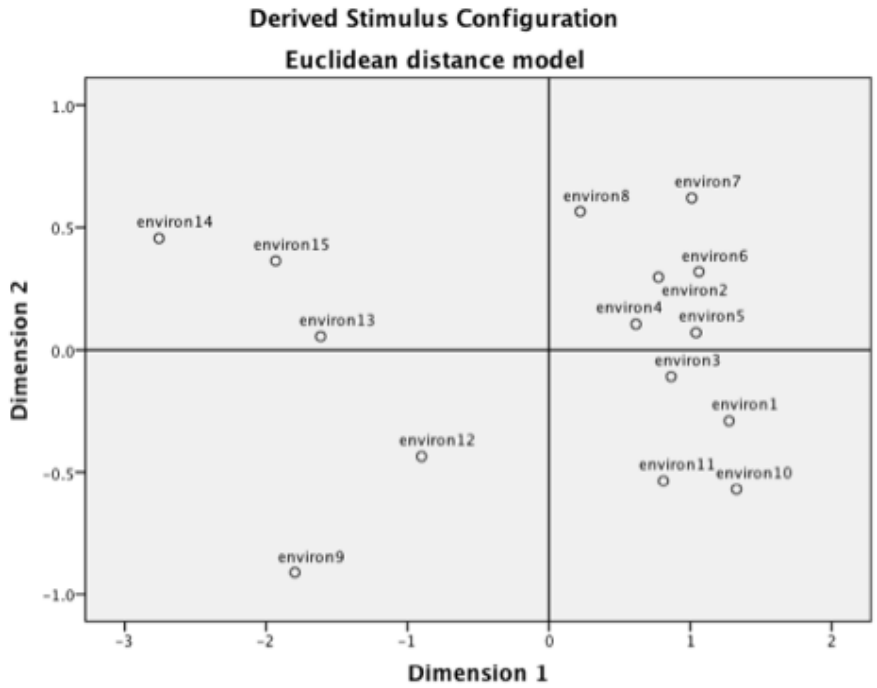


**Figure 2**. Two-dimensional multidimensional scaling solution for 15 items on the climate change attitude survey.

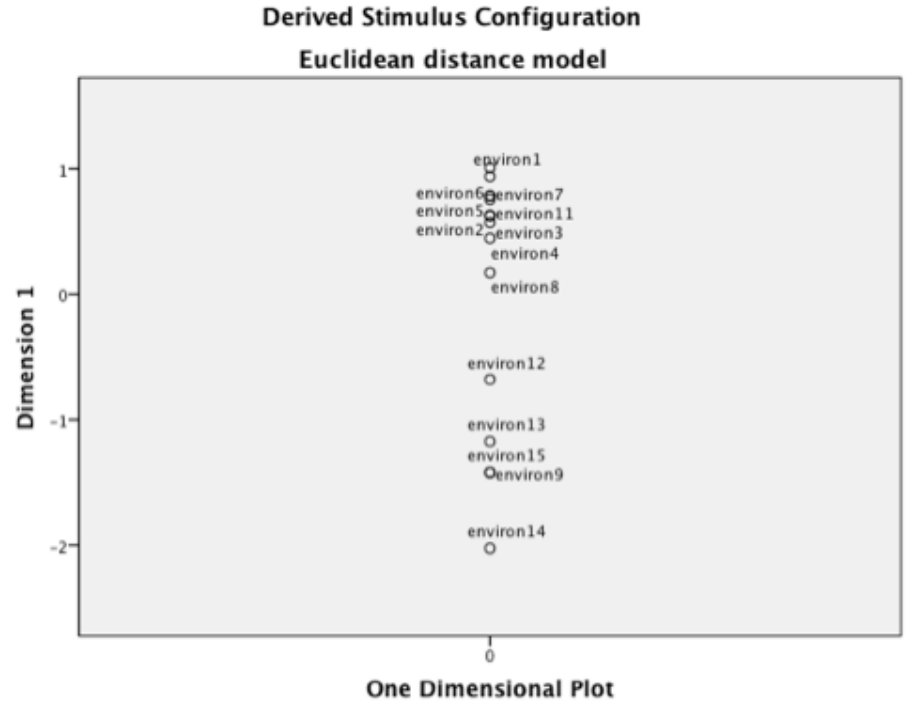


**Figure 3**. One-dimensional scaling solution for 15 environmental survey items.

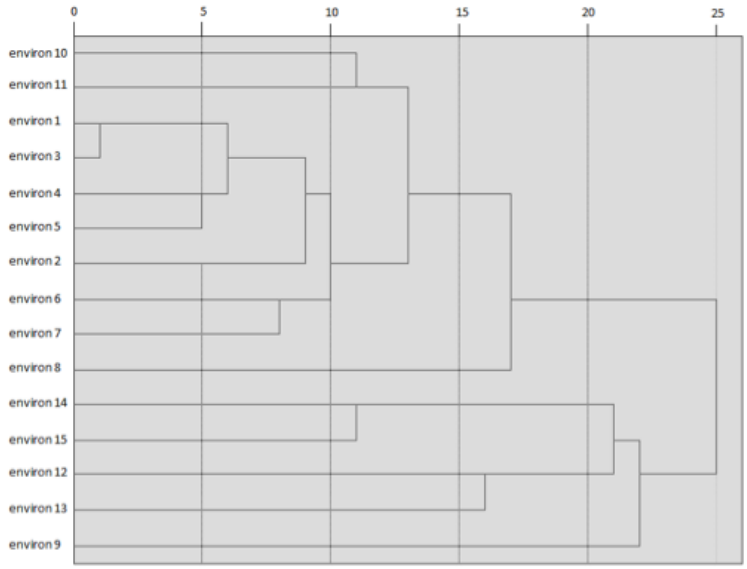


**Figure 4**. Hierarchical cluster analysis (between groups, average linkage) for relationship among 15 items.

## DISCUSSION

### Relationship of beliefs and intentions

The theory of planned behavior (Azjen & Fishbein, 1980) indicates there is reason to believe a relationship might exist between beliefs and intentions. A correlation was run to determine the strength of the relationship between the participant scores on the two scales. The significance level, $p$ <.01, indicates the two dimensions are related. However, the .222 correlation[1] would indicate only a small to moderate strength of relationship according to Cohen's guidelines ($r$ = .1, small; r = .3, moderate, r = .5, large). Follow up exploratory factor analyses revealed a similar correlation of $r$ = .28 between the construct axes themselves could be produced if a promax rather than varimax factor rotation scheme were used. The researchers elected not to accept this exploratory solution in order to preserve the statistical independence or orthogonality of factor scores which represent theoretical responses of participants regarding a construct, without error. Clearly, interest in climate change can be related to intent to help prevent it.

### Evidence of criterion-related validity

Post hoc reliability estimates of Cronbach's Alpha = .87 for Beliefs and .70 for Intentions were established through internal consistency reliability analyses for the two construct-based scales on the CCAS, and were judged to be respectable according to the criteria established by DeVellis (1991). The authors have demonstrated criterion-related validity through correlation of the CCAS total score with an established measurement scale (gathered at the same time) related to "wanting to become a scientist in order to make the world a better place" (Career Interest Questionnaire, Part 3) (Peterman, Kermish-Allen, Knezek, Christensen, & Tyler-Wood, 2015). The Pearson Product Moment Correlation of r = .47 ($p$ < .0005)

[1] The negatively worded items (9,12,13,14,15) were reverse-coded prior to analysis to allow comparison to the positively worded items.

between these two measures indicates a strong positive relationship with the strength of association approaching Cohen's (1988) criterion of .5 = large. Examination of subscale correlations with the independent measure of "wanting to make a difference in the world" revealed that Construct 1: *Beliefs* ($r$ = .49, $p$ <.0005) is strongly associated with the criterion measure of making a difference while Construct 2: *Intentions* ($r$ = .15, $p$ < .0005) is not strongly associated.

The remaining analyses in this section address the instrument's ability to distinguish between groups where there is prior indication that the groups might differ on the constructs assessed by the instrument. The treatment versus comparison groups for MSOSW project students showed no significant difference on climate change intentions for action but significantly ($p$ <.005) differed on beliefs about climate change. The effect size of .14 for Beliefs would be considered small (Cohen, 1988) and not educationally meaningful (Bialo & Sivin-Kachala, 1996). However, no meaningful differences for these disaggregated data groups were expected for this set of pretest data collected prior to the intervention.

The intentions factor was significantly different ($p$ = .04) for males versus females with females being higher. The effect size was .10, considered small (Cohen, 1988) and not educationally meaningful (Bialo & Sivin-Kachala, 1996). There was no significant ($p$ = .99) difference between males and females demonstrated on the scale measuring beliefs at pretest time.

The findings regarding treatment versus comparison and males versus females illustrate that the Climate Change Attitude Survey has two scales, each of which is capable of discriminating between groups of participants. No meaningful differences were anticipated in either of the disaggregated data groups selected since all data were gathered prior to the project activities. The primary purpose of this instrument is to measure pre-post changes and this validation increases confidence that it is capable of performing well for the intended purpose.

## Prospects for additional constructs

Since the development of the items for the Climate Change Attitude Survey, a new study for related concepts emerged in the literature. Specifically, a study (Le Hebel, et al., 2014) measuring environmental attitudes of 15 year-old students in France was conducted to identify the factors influencing students' attitudes toward the environment. While 18 of the items were focused on "me and my environment", the entire survey consisted of 250 items and was conducted through the educational system. The study had also been conducted in other countries and the data showed that the French students were more like other western countries having a lower level of concern for involvement in environmental problems and motivation for action compared to students from developing countries (Le Hebel, et al., 2014). This study may provide useful items for the next revision of the CCAS, as described in the following paragraph.

Two factors extracted from the data accounted for 47% of the common variance among the responses while the scree plot (Figure 1) indicated three or more constructs might exist in this domain. Future research is planned to determine whether version 2 of the instrument might be enhanced by adding items such as "I believe that I can contribute to the solutions of environmental problems by my actions" (Champeau, 1997), "Environmental problems can be solved without big changes to our way of life", and "I think each of us can make a significant contribution to environmental protection" (LeHebel, et al., 2014).

Additional limitations to this study and the new instrument presented are worthy of specification. Cronbach's Alpha is a "snapshot" (single time period) estimate of internal consistency reliability. A study of true test-retest reliability, where each subject completed the instrument twice (without an intervention) within a

reasonable time frame, could be performed to give a more accurate assessment of the true reliability of the instrument. The measurement characteristics of the relatively short version 1.0 of the instrument (15 items) could be improved by addition of parallel worded items in areas identified through the analyses presented in this paper. This is especially important if future researchers wish to pursue development of the third potential construct that emerged from factor analysis, to the level of which it could also become a respectable scale. Data from groups of students very different from those involved in the MSOSW project could be analyzed to reconfirm scale reliability and construct validity for more diverse populations. We cannot be certain that the performance characteristics of this new instrument used for just one study will maintain its consistency across diverse clientele and over time.

## CONCLUSIONS

Analysis of data from 1576 middle school students located in several states across the U.S. indicates that the Climate Change Attitude Survey (CCAS) has respectable reliability as an assessment instrument. Furthermore, factor analysis revealed that two constructs that are being measured by the CCAS – beliefs and intentions regarding climate change. Multidimensional scaling and hierarchical cluster analysis confirmed the two-factor structure. Respondents in this study were generally positive in their beliefs that the climate is changing and their ability to make an impact. It is possible that the alignment of the items (factor structure and internal consistency reliability) might differ for a group of participants who were of a different age or orientation toward environmental issues. The positive attitudes bias of this group of students is not surprising since participants in this study had teachers who volunteered to participate in the energy monitoring, National Science Foundation-funded project producing the data.

Nevertheless, the Climate Change Attitude Survey appears to be useful for measuring pre-post changes in middle school students as well as comparing subsets of a population such as males and females or school types such as urban and rural. Future studies could determine whether the instrument is also useful for assessing environmental beliefs and intentions among high school and university students, as well as other adult populations.

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## APPENDIX

## Climate change attitude survey

| | F1-Beliefs | F2-Intentions |
|---|---|---|
| 1. I believe our climate is changing. | * | |
| 2. I am concerned about global climate change. | * | |
| 3. I believe there is evidence of global climate change. | * | |
| 4. Global climate change will impact our environment in the next 10 years. | * | |
| 5. Global climate change will impact future generations. | * | |
| 6. The actions of individuals can make a positive difference in global climate change. | * | |
| 7. Human activities cause global climate change. | * | |
| 8. Climate change has a negative effect on our lives. | * | |
| 9. We cannot do anything to stop global climate change. | | * |
| 10. I can do my part to make the world a better place for future generations. | * | |
| 11. Knowing about environmental problems and issues is important to me. | | * |
| 12. I think most of the concerns about environmental problems have been exaggerated. | | * |
| 13. Things I do have no effect on the quality of the environment. | | * |
| 14. It is a waste of time to work to solve environmental problems. | | * |
| 15. There is not much I can do that will help solve environmental problems. | | * |

*Items 1-10 Christensen & Knezek, 2014*
*Items 11-15 Adapted from Wisconsin Center for Environmental Education (1994)*