

# Contrasts in Climate Change Attitudes and STEM Dispositions Among Children versus Adults Attending a Science and Technology Exposition

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## Abstract

Children and adults attending a three-day Science and Technology Exposition in Washington D.C., during April 2016 completed Climate Change Attitude Surveys and STEM Semantic Differential Surveys while visiting a booth featuring hands on demonstrations of testing various household appliances for consumption of standby power. Demos were conducted by middle school teachers from three states in the USA as part of a four-year Innovative Technology Experiences for Students and Teachers (ITEST) project, funded by grant #1312168 from the U.S. National Science Foundation (NSF). Findings were that adults overall were more positive than children but significantly higher than children only on the individual measures related to climate change. Overall the profiles of adults and children were similar. The authors conjecture this is due to the participants choosing to attend the expo event.

**Keywords:** STEM attitudes; climate change attitudes; informal science

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## 1 Introduction

This paper presents research findings based on data gathered from a large-scale informal science exposition event, focused on the question of whether the attitudes toward climate change as well as STEM dispositions in general differed for adults versus children attending the event. The event itself was a large exposition in the USA nation's Capitol, logging more than 100,000 visitors to the Walter Washington Convention Center April 15 - 17, 2016, and featuring events targeted for whole family interest. More than 1000 event participants visited the hands-on demonstration booth staffed by the University of North Texas as part of a four-year Innovative Technology Experiences for Students and Teachers (ITEST) project, funded by grant #1312168 from the U.S. National Science Foundation (NSF). The primary goals of the project Going Green! Middle Schoolers Out to Save the World are to focus pre-teen interest in activities that foster learning about energy consumption in students' homes and communities, and to incubate interests and knowledge about STEM majors and careers. This project was one of several invited by NSF to be among the hundreds featuring hands-on science activities at the exposition.

## 2 Background

### 2.1 The Middle Schoolers Out to Save the World Project

The MSOSW project was designed to develop middle school students' interest in STEM content areas and to prepare students for the STEM workforce. The ongoing project aims to direct middle school students' enthusiasm for hands-on activities, and to guide students to solve real-world problems. Students in this study are trained by their teachers to use energy monitoring equipment to audit standby power consumed by the electronic devices in the students' homes and communities. After measuring standby power, students gather their data together with their classmates in spreadsheet projections to explore energy conservation

plans that can lower a family's monthly electric bill and reduce the greenhouse gas emissions that contribute to global warming. Students share their results with other middle school students from across the U.S.

## 2.2 STEM Career Interest

A primary goal of the NSF ITEST program is to develop a better understanding the primary constituents of precollege experiences that encourage increased selection of STEM majors in college and eventual advancement to STEM careers (LRC, 2012). According to George, Stevenson, Thomason, and Beane (1992), STEM career intervention and enrichment plans should be initiated well before the high school years. Previous studies have found that students who have positive attitudes toward science at the middle school level are more likely to pursue a STEM career (Tai, Liu, Maltese, & Fan, 2006). For the MSOSW project, the focus is on middle school students because that is a critical juncture for choosing STEM-related courses for high school, if a student wishes to have an opportunity to pursue STEM career.

Not only is it important that the STEM workforce is developed, but it is critical that our citizens be scientifically and technologically literate (Milner, Sondergeld, Demir, Johnson, & Czerniak, 2012). As education and popular perception of technology and engineering standards evolve, there is an increased awareness of the need for STEM literacy within society. STEM literacy fosters intelligent participation in public socio-scientific and ethical decisions, which direct the future of engineering and technology (Gorham, 2002; Stiller, De Miranda, & Whaley, 2007).

Fortus (2014) published an editorial pointing out the lack of published research during the first decade of the 21<sup>st</sup> 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).

## 2.3 Climate Change Attitudes

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).

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).

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, Kardash, Taasobshirazi, & Lombardi, 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).

# 3 Instrumentation: Indicators of Climate Change Attitudes and STEM Interest

## 3.1 STEM Semantic Survey

The STEM Semantics Survey (Tyler-Wood, Knezek, & Christensen, 2010) was used to measure interest in each STEM subject as well as interest in STEM careers more generally. The STEM Semantics Survey was derived from earlier Semantic Differential research by Zaichkowsky (1985). Five adjective pairs were incorporated as descriptors for target statements reflecting perceptions of Science, Math, Engineering,

Technology and interest in a STEM career. Internal consistency reliabilities for the five scales of the STEM Semantics Survey typically range from  $\text{Alpha} = .90$  to  $\text{Alpha} = .94$  for students such as those participating in this study (Tyler-Wood et al., 2010). The five scales on the STEM Semantics Survey each have five items which are presented through semantic adjective pairs (boring: interesting; unexciting: exciting; and so forth) serving as anchors on a seven-point rating scale.

### 3.2 Climate Change Attitude Survey

The Climate Change Attitude Survey (Christensen & Knezek, 2015) is composed of 15 likert-type attitudinal items selected to measure students' beliefs and intentions toward the environment with a focus on climate change. The 15-item survey contains likert-type items on a 5-point scale from Strongly Disagree (1) to Strongly Agree (5).

## 4 Participants

The participants for the study were 104 adults (age 18 and beyond) with an average age of 42 and 34 children (ages 8 – 17) with an average age of 13 who attended the science and technology exposition in Washington DC during April 2016. While visitors to the Going Green! MSOSW project were waiting for a turn at the hands-on displays monitoring energy consumption of typical home appliances such as hand-held blow dryers, rice cookers, and coffee makers, they were invited to complete a brief survey in order to receive a reusable shopping bag branded by the project. Approximately two-thirds of the visitors to the Going Green! MSOSW booth came as family units, but some adults and some children visited on their own. Survey instruments recorded gender and age of the participants but no attempt was made to match children with their own parents.

## 5 Methodology

For this comparative analysis, tests for significant differences between group mean values and effect sizes estimating the magnitude of the differences between adults and students were the primary methodology used. Unpaired *t*-tests were calculated between adults and children for each of the measures and effect sizes (Cohen's *d*) were estimated.

## 6 Results

As shown in Table 1 and graphically displayed in Figure 1, adult attitudes and dispositions were higher than those of children in all seven areas measured. The likelihood of this occurring by chance is very rare (binomial  $p = .008$ ). Adults were significantly ( $p < .05$ ) higher than children on the individual measures of climate change beliefs ( $p < .007$ ) and climate change intentions to take action to alleviate the human actions contributing to climate change.

Attitude Measures	N1	Mean1	Std.	N2	Mean2	Std.	Signif.	Cohen's d
		Adults	Dev.		Children	Dev.		Effect Size
Science	32	6.44	.94	34	6.00	1.42	.145	.37
Mathematics	32	5.43	1.64	35	4.74	1.70	.096	.41
Engineering	32	5.69	1.67	33	5.63	1.44	.883	.04
Technology	32	6.29	1.39	37	5.72	1.94	.174	.34
Career	34	5.91	1.59	34	5.83	1.52	.833	.05
Climate Beliefs	104	4.43	.62	65	4.17	.55	.007	.44

Climate Intentions	104	4.27	.75	64	3.74	.92	.0001	.63
Ave.ES= .33								

Table 1. Contrasts in Climate Change Attitudes and STEM Dispositions Among Children versus Adults Attending a Science and Technology Exposition

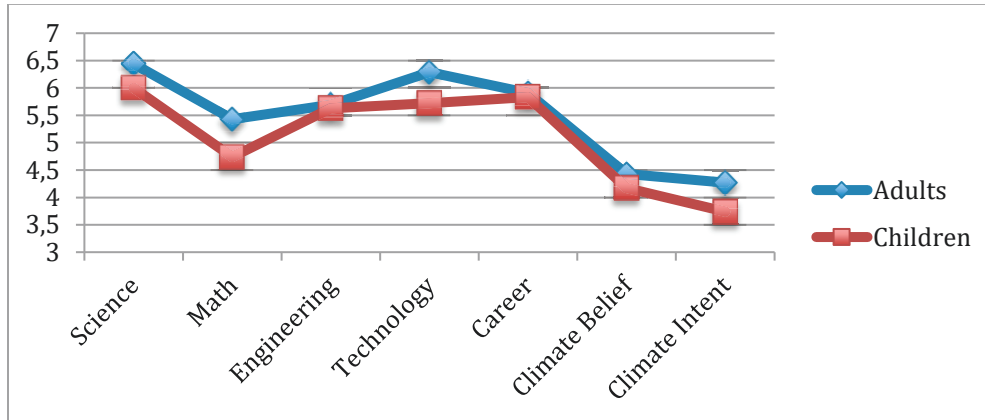


Figure 1. Comparisons of adult vs. children STEM dispositions and attitudes toward climate change.

## 7 Summary and Conclusions

Adults and children attending an informal science and technology exposition produced similar profiles of more positive versus less positive areas of ratings across attitudes toward climate change and STEM disciplines. Adults were somewhat higher than children in all areas, but adults were significantly ( $p < .05$ ) higher only in climate change beliefs and intentions. The similar response patterns found for children and adults, combined with the fact that approximately two-thirds of the respondents were parent-and-children family units, lead the authors to conjecture that the parents in this sample likely influenced the attitudes and dispositions of their children. The authors further conjecture that family influence might be an important contributor to promoting positive STEM dispositions in future generations. Additional research is needed to confirm or refute these conjectures.

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