

Increasing middle school student interest in STEM careers with videos of scientists

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Students are making choices in middle school that will impact their desire and ability to pursue STEM careers. Providing middle school students with accurate information about STEM (Science, Technology, Engineering, Mathematics) careers enables them to make more knowledgeable choices about courses of study and career paths. Practical ways of helping students understand the nature of science careers are limited. This study investigates using video interviews of STEM professionals as a method for better informing students about STEM career possibilities. ANCOVA analysis was used to compare treatment and comparison student interest in pursuing STEM careers before and after viewing video interviews with STEM professionals. Evidence for implementing video interviews as a way to interest middle school students in pursuing STEM careers exists. No gender differential in interest in STEM was detected.

Keywords: gender in science; middle school science; STEM career choice; student interest in STEM; videos in the classroom

Introduction

Recent reports from the Bureau of Labor Statistics (BLS) (2005, 2010) project that the U.S. will have a difficult time filling Science, Technology, Engineering and Mathematics (STEM) careers that will be vacant due to retirements and a decrease in student interest in STEM. Other evidence of this projected shortage is offered by the US Government Accountability Office who reports that from 1994 to 2003, STEM-related employment increased by 23%, with the greatest increase in mathematics and computer science, compared to 17% in non-STEM fields (Ashby, 2006). This brings to light the importance of focusing attention toward increasing student interest/attitude toward pursuing STEM, not just for literacy, but also for the purpose of developing careers. In fact, meeting humanity's biological needs for adequate and clean water, less pollution and an adequate food supply, along with our needs for housing, communications, and economic sustenance will be a challenge for 21st century scientists (Kanwar, 2010; Suzuki & Collins, 2009). Encouraging our youth to pursue careers in the STEM fields has been viewed as crucial in recent years, to meeting humanity's needs, both nationally and globally. According to the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine (NAS, NAE, IM, 2006), with the economies and broader cultures of the United States and other countries becoming increasingly dependent on science and technology, the United States K-12 educa-

tional programs are not producing enough students to prosper in these fields. Americans have both ecological *and* economical reasons to encourage students to pursue STEM careers.

How to increase the number of students entering the STEM pipeline in pursuit of a career is not clear. In efforts to further understand students' relationships with STEM, researchers have explored many areas. Among these areas are classroom instruction, gender, student attitudes, and aspirations. These are discussed in the following sections.

Classroom Instruction

Research on techniques that increase student achievement and learning in STEM at all levels has exploded over the last few decades. Various inquiry-based activities, have been studied and found to positively impact students' achievement (Akkus, Gunel & Hand, 2007; Gibson, 2002; Liu, Lee, & Linn, 2010; Shrigley, 1990) and attitudes toward STEM (Chung & Behan, 2010; Lord & Orkwiszewski, 2006). Cooperative learning, in which students are placed in social groups for class activities, has frequently been studied as a classroom method for improving learning and broader gains including improved attitude toward STEM (Gupta, 2004; Kose, Sahin, Ergu, & Gezer, 2010; Lord, 2001; Thurston, Topping, Tolmie, Christie, Karagiannidou, & Murray, 2010). Other techniques that frequently appear in STEM-education literature include Project-based learning and hands-on activities (Colley, 2006; Kanter & Schreck, 2006; Kramer, 2008; Randler & Hulde, 2007; Satterthwait, 2010; Stohr-Hunt, 1996) active-learning, concept mapping, and student-centered learning (Freedman, 1997; Sturm & Bogner, 2008; Taraban, Box, Myers, Pollard & Bowen, 2007; Turner, 2011). These techniques are studied across all subject areas and age groups and frequently demonstrate that students' experiences in the classroom are enhanced through these techniques. There is no argument that these instructional techniques have a great deal to offer. However, these studies tend to be smaller and not generalizable to the broader populations needed in order to maximize input into the science pipeline and have not been linked to STEM career aspirations.

Gender and STEM

Some studies look to increase the representation of women in STEM fields where they are not as participatory. While the ratio of women to men in biological sciences has reached parity at some levels, men and women are not represented equally in many STEM fields (NSF, 2007). Differences in student attitudes, interest and achievement in science across gender are frequently studied to understand the divergence in representation. While the findings tend to differ by subject and age, males overall typically demonstrate a higher interest in science-related study creating a paucity of women in certain STEM fields (Caleon & Subramaniam, 2008; Jones, & Howe 2000; Keeves & Kotte, 1992; Schibeci & Riley, 1986).

The reasoning behind variations across gender has been explored by researchers. Christidou (2006) reported from a study including 583 ninth grade Greek students that females are more interested in topics related to human biology, health and fitness, while males are more interested in science, technology, and the threatening aspects of science and technology. Interest in a particular subject is influenced by individual factors and situational factors (Bergin, 1999). The measured differences across gender for interest in STEM fields could be explained by the variation in experiences (situational factors) that boys and girls have. Science-related experiences for boys and girls have been shown to vary (Jones & Wheatley, 1990; Kahle & Lakes, 1983). In addition, media influences have been theorized to impact student perceptions and attitudes in terms of STEM careers. Gender stereotypes portrayed in the media about STEM-related careers may influence children's perceptions of themselves in regard to their ability to succeed in STEM

careers and the gender appropriateness of doing so (Steinke, Lapinski, Crocker, Zietsman-Thomas, Williams & Kuchibhotla, 2007). This can lead to poorer performance for girls even when they are highly capable of succeeding in these areas (Smith, Sansone, & White 2007) thus reducing aspirations and goals related to the stereotype (Davies, Spencer, & Steele, 2005). Whatever the cause behind it, the measured difference across gender may indicate that the methods with the greatest impact on boys' and girls' interest in STEM may vary and researchers need to identify appropriate ways to respond to this.

Student Attitudes, Interest, and Perceptions

For decades research on students' perceptions of scientists has demonstrated that students do not have a clear perception of what science has to offer them or what scientists do. In 1957, Mead and Metraux, analyzed student essays that detailed their ideas about scientists. They found that students perceived scientists as old, white males working in a laboratory performing dangerous experiments. Variations of this study have been conducted several times since and, with the exception of some very slight changes, the overall stereotype of the older white male chemist persists (Barman, 1997; Beardsley & O'Dowd, 1961; Bodzin & Gehringer, 2001; Chambers, 1983; Etzioni & Nunn, 1974; Finson, Pedersen, & Thomas, 2006; Hills & Shallis, 1975; Mason, Kahle, & Gardner, 1991; Rodriguez & Gomezgil 1975; Schibeci & Sorensen, 1983; Turkmen, 2008; Ward, 1986).

The impact this false perception may have on career aspirations is left somewhat unmeasured. Morgan, Isaac and Sansone (2001), studied undergraduate college student perceptions and aspirations for careers and found that the perception of interestingness, positively predicted the likelihood of career choice. The variables determining interestingness were different for men and women, partially explaining the difference in career choices. This study demonstrates a clear link between student perceptions and career aspirations but this is relatively unexplored at the younger levels. Schibeci and Riley (1986) analyzed National Assessment on Educational Progress data to demonstrate a causal link between high school student attitudes about science and achievement. This relationship was further teased out by Mattern and Schau (2002) who found that the best-fit model for middle school boys and girls differs. While boys' achievements and attitudes are closely linked, for girls they are essentially separate further complicating the potential methods for intervention. In one study on the direct link between perceptions and career interest, Buldu (2006) worked with 30 elementary school children and found that students' perceptions of scientists influenced their interest in science-related careers. This is consistent with psychological research findings on middle school students demonstrating that students' occupational preferences and career aspirations are strongly linked to their images of particular occupations (Gottfredson, 1981). This leads to the conclusion that holding false perceptions of scientists can prohibit students from pursuing science, emphasizing the importance of correcting these perceptions (Zeldin & Pajares, 2000).

Career Aspirations

The connections between attitudes, interest and perceptions are seemingly very complicated and fairly unexplored in direct relation to career aspirations. Links have been made between a student's basic knowledge of what a particular STEM profession is and involves and their interest in pursuing that area of study (Robinson & Kenny, 2003). While research has shown that students are making decisions about their careers as early as middle school (Tai, Liu, Maltese & Fan, 2006) students at this age may lack exposure to the career possibilities in the STEM fields and therefore may be making decisions about career choices without accurate information. Caleon

and Subramaniam (2008) studied 580 fifth and sixth grade students and found that 33% of the 5th and 6th graders in their study in Singapore were “not sure” about their preference toward a science career. While it is not clear if these numbers exactly reflect students in the United States, it brings attention to the fact that at least some students who are inclined to STEM may not know enough to make informed choices about STEM classes and career paths. Gottfredson (1981) argued that, during adolescence, aspirations become more realistic, based on student interests, perceived abilities, and individual characteristics as well as the opportunities available to them. If students do not have accurate perceptions of STEM professions, or feel a personal connection (Buldu, 2006; Osborne & Collins, 2001) to these professions, these career options may be left out of this developmental process. It is possible that researchers have avoided using student projections of a desired career as an outcome because the reliability of this may be questioned. Using National Educational Longitudinal Study data, Tai *et. al.* (2006) found that early adolescents who indicate they are interested in pursuing a career in science were three times more likely to graduate with a science degree, making career aspirations during middle school an important predictor for STEM professions. In addition, psychological research tells us that adolescence is a time when students are exploring new things and furthering their sense of identity in relation to future plans (Eccles, Barber, Stone, & Hunt, 2003). Adolescence is an important time to focus on career development, and pursuing studies with this outcome in mind could better inform us about student attitudes, interest and perception and the way this is related to their career aspirations.

Bridging the disconnect between students and science careers is a common recommendation that comes from studies (Barman, 1997; Finson, 2002; Palmer 1997). Palmer (1997) interviewed students to find out whether students had other ideas about scientists, apart from the stereotyped images depicted in the DAST. One of the conclusions that came from his interviews is that students do not view science as having personal relevance to them. Yet a practical way of changing this on a large scale has not been disseminated. In an effort to make science real to students, Bodzin and Gehringer (2001) brought physicists into two fifth-grade classes to speak with students about physics and what scientists actually do. The students were asked to draw a scientist before and four weeks after the visit. The results showed a decrease in stereotypic features in the students' drawings. The authors conclude that having students interact with scientists during class time influenced the students' perceptions. Though this study shows promise in correcting student misconceptions of scientists and exposing students to STEM career options, it is not practical to implement on a broad scale. Schools that do not have access to STEM professionals or cannot get them to the classroom on a regular basis cannot implement this. In addition, schools that are able to bring STEM professionals in are not likely to be able to represent a variety of careers which may limit the number of connections made with students because of students' personal interests.

In an effort to increase the number of students who will pursue STEM study and careers, we need to increase student awareness of a variety of STEM careers early on. Students who are offered this information in school will be better able to make informed decisions about their interest in STEM and better prepare for those careers.

This study examines the impact of informing middle school students about STEM careers through the use of videos in the classroom. The research question driving this study is: Does showing video interviews with STEM professionals about their careers, increase middle school students' interests in pursuing careers in the STEM fields? Videos are typically shown in schools on a regular basis, so incorporating videos about STEM professionals will not require special equipment or access to universities or other organizations and professionals. A teacher can use videos to complement a curriculum easily making this method feasible for large-scale

implementation. The purpose of the videos is to offer accurate information about STEM careers so that students can make informed choices in terms of career pursuit.

Middle school students were selected for the study because their attitudes and interests in future careers may not be firmly set, and by the time students are in high school, attitudes and interests in the sciences have already declined (George, 2000). Caleon and Subramaniam (2008) concluded that there is great potential in intervening with middle school students because many of them are undecided in their attitudes toward science as a career preference. Their findings reveal the importance of providing students with accurate information about STEM careers early.

Informing students about STEM career options could play a vital part in maintaining competitiveness in the global market. Caleon and Subramaniam (2008) suggested that efforts be concentrated on generating materials that provide information that would inspire students who are inclined to science to follow a path leading to science careers. This study responds to this need.

Methodology

The purpose of the study was to investigate whether middle school students' interest in pursuing STEM careers is impacted by exposure to information about those careers. Specifically, does viewing recorded interviews with STEM professionals about their work influence student interest in STEM careers? In order to answer this question a two-phase study was developed. In the first phase, STEM professionals were interviewed about their work. These interviews were recorded and edited for clarity, efficiency and appeal to adolescent viewers. In the second phase of the study the videos were shown to middle school students over an eight-week period. The students' interest in STEM careers was measured via survey at three intervals (before viewing the videos, after half of the videos were viewed, and after all of the videos were viewed). This data was analyzed to detect any changes in student interest in STEM careers.

Video Development

For the selection of the STEM professionals, criterion sampling was used. Participants who work in a science, engineering, technology or mathematical field, with at least a bachelor's degree, were selected. Based on these criteria, participants were recruited by the researchers using email to various businesses and universities, in a blanket invitation to its employees in STEM fields to be part of this research project. Recruitment also occurred through snowballing with acquaintances and colleagues that the researchers knew (Patton, 2003).

Once a possible candidate was established, contact was made using email or the telephone to introduce ourselves, confirm their professions fit our study, further discuss the purpose of our study, and to establish their willingness to participate. Once these preliminaries were established, an interview date and time was selected.

The resulting sample population for the videos (from here on referred to as interviewees) included professionals who had post-secondary degrees: five Bachelors degrees, one Master degree and three Doctorate degrees. The interviewees represented several areas of STEM (see Table 1). Five men and three women were interviewed and recorded with video. Although ethnic diversity was sought, those willing were all of Caucasian descent. The ages of those who participated ranged from 24 to 53.

The interviews were semi-structured with pre-set questions to help guide the interview (Appendix A). Interviewees were asked about their career choice, the path that led them to their field of work, and the work involved in their jobs. Discourse was allowed for interest and variety

in the interview. The content of the interviews varied by interviewee. Each spent significant time describing the different responsibilities in their jobs. When the jobs were more field-based (i.e., Agronomist) the interview included descriptions and video of soil sampling. The Engineers described the purpose of their jobs while the Marine Biologist spent time describing her work environment.

Table 1. STEM Professionals in Order of Classroom Implementation

Video	Gender	STEM Area
1	Female	Marine Biology
2	Female	Genetic Toxicologist
3	Male	Control Engineer
4	Male	Asst. Prof. Bat Studies
5	Male	Microbiologist
6	Female	Forensic Scientist
7	Male	Research Engineer
8	Male	Agronomist

The interviews were digitally recorded with video and the resulting footage was edited into 10-15 minute videos from each interview. The editing process removed silent moments, “uhms,” and interruptions. Questions which were not highly expanded upon beyond a simple answer may have been removed to conserve time, while those responses in which the interviewees freely explained themselves and their careers with depth, and even enthusiasm, were retained.

Study Participants

The participants included Sixth-grade and Eighth-grade students at a small middle school in the Midwest. The school population K-12 in 2009 was 537 students. The participating school is a laboratory school to a small mid-western university. At the time of the study, the school was comprised of 78% white students, 9% multiracial students, 7% black students, 4 % Asian students, and 1% Hispanic students. The study was conducted in four science classes (2 sixth grade and 2 eighth grade). One sixth-grade section and one eighth-grade section was randomly assigned to the treatment group, while the other sixth-grade and eighth-grade sections were assigned to the comparison group. The treatment groups viewed eight videos of STEM professionals, while the comparison group served as a control and did not see the videos during the study. The treatment groups included 18 sixth-grade students and 23 eighth-grade students, while the comparison group included 21 sixth-graders and 22 eighth-graders.

All the students in both the treatment and comparison groups were in classes with the same teacher, therefore both groups were exposed to the same teaching style and lesson plans. Both groups of students received the same questions in the pre- mid- and post-tests on their interests in STEM careers. Differences between the groups over the time period, using pretest mid-test and post-test results, were measured.

Survey

The survey has 27 total questions (Appendix B), and asks for general descriptors of the participants such as gender, ethnicity and grade level. The survey was designed to delve into students' opinions of science and science-related careers. The formats of the questions are True/False, four-part Likert-type, open-ended, and multiple-choice. Although the survey covers many aspects of science and science-related careers which can potentially be used for further research, this study focused specifically on the quantification of Likert statement: "I would consider being a scientist." Potential responses consisted of: Strongly Agree/Agree/Disagree/Strongly Disagree. For statistical analysis, the Likert question was scored as: 1 = Strongly Disagree, 2 = Disagree, 3 = Agree and 4 = Strongly Agree.

The use of a comparison group helps to ensure validity of the measurement tool. In addition students were asked not to discuss the survey or the videos for the duration of the study to avoid treatment diffusion. Students in the comparison group were told they would be allowed to see the videos at the end of the study to help alleviate rivalry or resentment that may impact the data. Because this is a pilot study, and reliability measures have not been established, the reliability was assessed using Pearson's r -value on the comparison group's pre-test and post-test scores for their interest in Science. Pearson's r -value was calculated and found to show a statistically significant, strong positive correlation between the pre-test and post-test scores within the comparison group, $r(37) = 0.75$; $p < 0.001$. Therefore, there is strong evidence that the test-re-test reliability of the students' responses is good.

Data Analysis

The hypotheses were tested using analysis of covariance (ANCOVA). A total of eighty-nine students were invited to participate, of which five (6%) declined. Of the remaining 84 students, eight (9%) were absent on the pre-test data, nine (11%) were absent on the mid-test data, and twelve (14%) were absent on the post-test data. Students who did not take at least two surveys for comparison were dropped from the analysis. The mean and standard deviation for each of these test groupings is shown in Table 2. Minimum and Maximum refers to the range of the four-point Likert scale used in the survey.

Forty-one students were in the treatment group, and 43 students were in the comparison group. For the ANCOVA, pre-test versus mid-test, the comparison group had 37 students (86%), the treatment group had 32 (78%). For the pre-test versus post-test, the comparison group had 36 students (84%), while the treatment group had 30 students (73%). In the mid-test versus post-test analysis, the comparison group had 35 students (81%), and the treatment group had a total of 31 students (76%).

Table 2. Descriptive Statistics for Survey

	N		Mean	Std. Deviation	Minimum	Maximum
	Valid	Missing				
Pre-test	76	8	2.368	1.0275	1.0	4.0
Mid-test	75	9	2.307	1.0230	1.0	4.0
Post-test	72	12	2.403	1.0300	1.0	4.0

Results

Students' interest in pursuing STEM careers before, at the midpoint and after viewing the videos were compared. We looked for changes in student interest after viewing just four videos, and again after viewing eight videos to observe any accumulated impact as the number of videos increased. Students in the treatment groups were compared to students who did not view the videos at each interval. Gender was also controlled for and is discussed in the results and discussion.

In this study, eighty-four students participated, of which 47 (56%) were males, 37 (44%) were females. For grade level, 39 (46%) were in the Sixth grade, and 45 (54%) were in the Eighth grade. There were 43 (51%) students in the comparison group, and 41 (49%) students in the treatment group. To determine if gender and grade level distributions were similar for the treatment group and the comparison group, a Chi-square test was used. This analysis shows there was not a statistically significant difference between the treatment and comparison group, Chi-square(1) = 0.82; $p = 0.37$, $\alpha = .05$. To determine if a difference existed between the treatment and comparison groups for grade level, Chi-square was again utilized. Results show no significant difference between the groups for grade level, Chi-square(1) = 0.21; $p = 0.65$, $\alpha = .05$.

ANCOVA was used for testing the homogeneity of slopes assumption for pre-test versus mid-test comparison. The interaction between groups and the pre-test score was not statistically significant, $F(1, 65) = 1.06$; $p = 0.31$. Therefore, the assumption of homogeneity of slopes was accepted.

The group (treatment versus comparison) was a statistically significant predictor of mid-test score, $F(1, 66) = 4.41$; $p = 0.039$; partial $\eta^2 = 0.063$. Therefore it was concluded that there is a difference in the average mid-test score between the treatment and comparison groups when adjusting for the pre-test score (Table 3). By adjusting for the pre-test score ($M = 2.35$), the average mid-test score was 2.13 for the comparison group, and 2.47 for the treatment group. The significant p -value (i.e. p less than the alpha level of 0.05) suggests that the videos increase students' interest in STEM careers over the pre-test to mid-test time period. However, the partial eta squared value of 0.063 means that the treatment explains only 6.3% of the total variance in mid-test scores when controlling for pre-test scores.

In using ANCOVA to test for the homogeneity of slopes assumption, the interaction between the groups and the pre-test score was not statistically significant, $F(1,62) = 0.015$; $p = 0.70$, with post-test score as the dependent variable. Assumption of homogeneity of the slopes is accepted.

Table 4 illustrates the results of the ANCOVA test and whether the group could predict the post-test score when controlling for the initial pre-test score. The results show that the group in which the students were placed was a statistically significant predictor of the post-test score, $F(1,63) = 5.81$; $p = 0.019$, partial eta squared = 0.084. There is a significant difference in the average post-test score between the treatment and comparison groups when adjusting for the pre-test score.

After adjusting for the pre-test score ($M = 2.43$), the adjusted average means of the post-test score for the video was 2.71, and for the comparison group, 2.24. The p -value of 0.019 suggests that the videos increase students' interest in STEM careers over the pre-test to post-test time period. The partial eta squared value of 0.084 (Table 4) means that the treatment group explains 8.4% of the total variance in the post-test scores when controlling for pre-test scores.

Homogeneity of regression slopes assumption was again met when comparing mid-test versus post-test results. The interaction between group (treatment versus comparison) and the

mid-test score was not statistically significant, $F(1,62) = 0.19$; $p = 0.66$, for the post-test as the dependent variable.

Table 3. ANCOVA Pretest versus Midtest

Source						
	<i>df</i>	Mean Square	<i>F</i>		η^2	<i>p.</i>
Corrected Model	2	22.075	49.300 ***		.599	.000
Intercept	1	2.985	6.667 **		.092	.012
Group	1	1.977	4.414 *		.063	.039
Pretest	1	42.240	94.334 ***		.588	.000
Error	66	.448				
Total	69					
Corrected Total	68					

* $p < .05$; ** $p < .01$; *** $p < .001$; a. R Squared = .599 (Adjusted R Squared = .587)

Table 4. ANCOVA Pretest versus Posttest

Source						
	<i>df</i>	Mean Square	<i>F</i>		η^2	<i>p.</i>
Corrected Model	2	13.879	22.650 ***		.418	.000
Intercept	1	10.115	16.507 ***		.208	.000
Group	1	3.563	5.814 *		.084	.019
Pretest	1	24.445	39.892 ***		.388	.000
Error	63	.613				
Total	66					
Corrected Total	65					

* $p < .05$; ** $p < .01$; *** $p < .001$; a. R Squared = .418 (Adjusted R Squared = .400)

Table 5 shows the results of the ANCOVA when comparing mid-test to post-test scores. The group (treatment versus comparison) was not a significant predictor of the post-test score, $F(1,63) = 2.14$; $p = 0.15$, partial eta squared = 0.033. It was concluded that there is no difference in the average post-test score between the treatment and comparison groups when adjusting for the mid-test score.

After adjusting for the mid-test score ($M = 2.36$), the average post-test score was 2.31 for the comparison group and 2.58 for the treatment group. Overall, there is insufficient evidence to show that the videos increase students' interests in STEM careers over the mid-test to post-test time period.

ANCOVA was utilized comparing the survey scores to explore impact of gender and grade level on student interest in STEM careers. Neither gender nor grade level was found to be a significant predictor of any test stage (pre/mid/post).

Table 5. ANCOVA Midtest versus Posttest

Source	<i>df</i>	Mean Square	<i>F</i>		η^2	<i>p</i>
Corrected Model	2	18.350	34.449	***	.522	.000
Intercept	1	6.430	12.071	**	.161	.001
Group	1	1.137	2.135	*	.033	.149
Midtest	1	32.429	60.882	***	.491	.000
Error	63	.533				
Total	66					
Corrected Total	65					

* $p < .05$; ** $p < .01$; *** $p < .001$; a. R Squared = .522 (Adjusted R Squared = .507)

Discussion

Results from the answers on the pre-test, mid-test, and post-test surveys on students' interest in science were analyzed for treatment group, gender and grade level. ANCOVA was used for the analysis. The major findings of this study were that the treatment group had significantly higher mid-test and post-test scores compared to the control group, when the pre-test was the covariate. Post-test scores were not significant between the two treatment groups when mid-test scores were used as the covariate. Findings for gender suggested that there is no difference in males and females for interest in pursuing a STEM career when treatment group and grade level were controlled. Grade level comparisons between the two treatment groups found no significant difference between the Sixth grade and Eighth grade in interest in pursuing a STEM career when group and gender were controlled.

When comparing adjusted mid-test scores of the experimental and comparison group, and using the pre-test as a covariate, a significant difference on the mid-test scores between the treatment group ($M=2.47$) and comparison group ($M = 2.13$) was found. When the adjusted post-test scores were compared for the two treatment groups, using the pre-test as the covariate, again, a statistically significant difference between the experimental group and the comparison group was found. There was a significant difference between the mean post-test score for the experimental group ($M=2.71$) compared to the comparison group ($M = 2.24$). These results suggest that the viewing of these videos of STEM professionals is related to an increased interest in STEM careers and students may benefit from being exposed to STEM careers in this way. However, the effect sizes stated previously (0.063 for pretest versus mid-test and 0.084 for pre-test versus post-test) are small, which indicates that there are other factors which influence a students' consideration in becoming a scientist. Interest development theory indicates that changes in interest are gradual (Nolen, 2006, 2007) and require multiple triggers (Azevedo, 2006; Renninger, et.

al. 2008), suggesting that this impact could be improved with supplemental efforts for increasing students interest in pursuing STEM as a career and that the greatest impact will not be recognized through one method.

When the experimental group post-test score and the comparison group's post-test score were adjusted to the mid-test score, no significant difference was found. These results could be interpreted in a few ways. First, this could suggest that four videos were enough to produce a significant increase in the interest level at mid-test, but once the interest level was raised, the elevated interest was *retained* at post-test, but not *significantly increased* from mid- to post-test, thus the significant difference in interest was attained by mid-test. This would suggest that the additional four videos shown between the mid-test and post-test might not be of benefit. However, time is a factor in the measurement of interest, and over longer periods of time, elevated interest may start to wane. The additional four videos should not be ruled out because there is the possibility that if this study were done over a longer period of time the additional videos might be needed for retention of interest. Studies in psychology on interest and identity development indicate that without support, individuals can lose interest in areas where they once had well-developed interest (Bergin, 1999; Renninger, 2000). The results of this study indicate that four videos were enough to significantly impact student interest. Maintaining that interest or further developing that interest may require further support in the form of more videos or some other method. Longitudinal research is needed to further tease out the details of this relationship.

A second way to interpret this result is that the order in which the videos were shown impacted the variation. In other words, it could be that the first four videos shown included the content that was of greatest impact on student interest for this group of students. Future studies of this kind should take into consideration the order of the videos and the particular interests of the students in the group. STEM represents many careers and it is difficult to say if the results in this study would be different if other STEM careers were highlighted.

It may also be more beneficial to align the videos with the curriculum in the classroom, so that while students are learning about plant morphology or plant pathology the video they watch is an interview with a horticulturalist. Contextualizing the videos in this way may increase the relevance of the videos, which has been identified as an important factor (Palmer, 1997).

Gender did not prove to be a factor in this sample of students. While this study represents a small subset of the population, the reasons behind this are worthy of further exploration. Some research demonstrates that interest in specific STEM fields varies across gender (Christidou, 2006). The analysis of this study did not disaggregate STEM fields. While effort was made to represent women in STEM fields in our video development, further exploration into the variation in student preferences across gender may be warranted in order to ensure the videos are offering information that is useful to all students.

Siegel and Ranney (2003) have found that there are different categorizations of attitudes toward science, such as a students' disposition, opinion, affect and belief; all of these collectively can affect a students' attitude toward science. Therefore, defining "attitude" becomes difficult and can be dependent on the approach and the definition used when the research is conducted. This current study was not specifically focused on attitudes toward science, but rather interest in becoming a scientist. However, there is likely overlap between the two. The current study has shown that middle school student interest is affected by informing students about potential careers through videos of STEM professionals, but attitude was not intentionally addressed. Nevertheless, the distinction between these two words may not be easy, because attitudes have been found to affect interest in science (Hanson, 1996; Kahle & Riley, 1993).

Conclusions and Implications

Attitudes toward and beliefs about science can be affected by factors such as teachers (Rosenthal, 1993; Thomas, Pederson, & Finson, 2001), classroom activities and settings (Ornstein, 2006; Siegel & Raney, 2003), students' self-concept (George, 2000), and media images (Brophy, 1983; Finson, Pederson, & Thomas, 2006; Morgan, 1982; Rosenthal & Jacobson, 1968; Rubie-Davies, 2006; Signorielli, 1997). Research suggests that if these influences can affect attitudes and beliefs, then interest is also affected (Hanson, 1996; Kahle & Riley, 1993). This study has shown that offering students accurate information about STEM careers via video interviews with STEM professionals is related to students' interest in pursuing STEM careers. Although the effect size in this study was small, Robinson & Kenny (2003), report that one reason students pursue a STEM career in college is their prior knowledge of what a particular profession in the sciences is and what it does. By making students aware of possible STEM careers through the use of video interviews of STEM professionals, more students may pursue STEM careers. The results of this study provide evidence that increasing student awareness of these jobs in this way does increase interest in pursuing careers in the STEM fields in middle school students. If this positive impact on students' interest could be maintained and combined with other in-class and out-of-class methods that show promise, our future need for students majoring in the STEM occupations in college might be filled. Educators are encouraged to seek out methods for incorporating this type of information into their lessons. Videos are one method for doing this easily and enable the representation of many STEM fields.

Economically, STEM advancement is needed for a country to thrive in a global economy. The capabilities of STEM to invent new technology in medicine, agriculture, computer science, transportation, along with the capability of STEM to solve problems ecologically, for example, push those nations with STEM capabilities to the forefront. Economically, those nations who have the people resources to invent and solve problems benefit from the inventions of those in the STEM careers. For America to compete on a global scale, she must maintain an interest in STEM in the minds of her people, so that the inventions and problem-solving, for which America has been known, may continue and allow her citizens to flourish.

Limitations

Limitations to this study include the limited diversity in student participants (use of one school, with the same teacher). It is not known whether these results could be replicated in a different school, or in a different geographical area. Another limitation to the study is the STEM professionals used for the videos were not ethnically diverse. A more diverse sampling of STEM professionals might impact the student population positively, showing them that individuals of all ethnicities can succeed in STEM careers.

The long-term effects of this study also are not known. How long the interest in pursuing a STEM career may remain could be a further investigation. A follow-up study on the students surveyed could provide insight into whether their interest remains through high school and into college. The analysis of this study is based on one item on a survey. While the study includes a comparison group, the strength of the study would be improved by including more data or supplemental qualitative data to provide support for the findings. Future studies should include other sources of data to triangulate the data and strengthen findings.

It is also important to consider the quality of the videos. The videos used in this study were created by the researchers who had no training in educational video production. In future studies, improving the quality of the video to align better with current media influences, may

increase the impact of the videos on student interest in STEM careers. Further research on this method for increasing student interest in pursuing STEM careers should be planned to explore the longitudinal effect of videos and to disseminate the videos to a larger sample size, to see if other schools with different demographics are impacted in the same way. Some attention toward the representation of a variety of careers and diversity in STEM professionals should be explored as well in an effort to reach as many students as possible.

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Appendix A. STEM Professional Interview Protocol

Tell me about your job?

How did you end up doing this job?

What does your day usually look like?

What is the best part of your job?

What is the worst part of your job?

Do you consider yourself to be a scientist?

How would you explain to a middle school or high school kid what being a scientist is about?

What do you remember most about science as a kid in school?

How did you know science was for you?

What would you recommend to kids who might like to pursue this as a line of work?

Appendix B. Middle School Science Student Post-Study Survey

Name: _____
Teacher: _____
School: _____
Date: _____

Thank you for participating in our study. We are interested in knowing about how you feel about science. The answers that you provide will not be used toward your grade in science or test scores. Participation in this is strictly voluntary and you do not have to complete the questionnaire if you do not want to. You may omit any questions you do not want to answer.

1. Are you a boy or a girl? Boy Girl
2. Please indicate your race or ethnicity (circle all that apply):
a) Asian b) Black/African American c) Hispanic or Latino/a d) White
e) Native Hawaiian/Pacific Islander f) American Indian/Alaska Native

Circle the pod-casts that you remember seeing (circle all that apply).

Week 1 (describe pod-cast from week 1)
Week 2 (describe pod-cast from week 2)
Week 3 (describe pod-cast from week 3)
Week 4 (describe pod-cast from week 4)

Week 5 (describe pod-cast from week 5)
Week 6 (describe pod-cast from week 6)
Week 7 (describe pod-cast from week 7)
Week 8 (describe pod-cast from week 8)

Which ONE did you find most interesting? (circle the MOST interesting one)

Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8

What do you remember most about it?

Circle T or F to indicate whether or not the statement is true or false.

Scientists have already found answers to most of the questions about nature. T F

American scientists have made few contributions to science. T F

Men generally make better scientists than women. T F

Scientists are too busy at their work to have much fun. T F

All scientists have to follow a specific method to solve problems. T F

After making a discovery scientists must also try to find ways to use it. T F

Science has been part of human existence since our earliest ancestors thousands of years ago. T

F

When I graduate I would like to choose a career in a field related to science or technology. T F

Science has played a great part in improving our standard of living. T F

Scientists often make errors and become frustrated because their experiments are not successful. T F

Many scientists do not have friends. T F

Which do you think scientist's spend most of their time doing while working?

- A) Solving problems
- B) Writing papers on science
- C) Reading science
- D) Doing experiments
- E) Teaching classes in science
- F) Thinking about science
- G) Talking to other scientists

Do any of those options sound like fun to you? YES NO

If you said YES, then which ones sound like fun? (circle all that apply)

- A) Solving problems
- B) Writing papers on science
- C) Reading science
- D) Doing experiments
- E) Teaching classes in science
- F) Thinking about science
- G) Talking to other scientists

How much do you agree or disagree with the following statements?

	Strongly disagree	Disagree	Agree	Strongly agree
Being a scientist is harder than other jobs				
I am smart enough to be a scientist				
Being a scientist is more fun than other jobs				
Scientists are strange				
Scientists get to do interesting things				
I know what some scientists do				
I know how to become a scientist				
Scientists are too busy to have friends and family				
Scientists help people				
I would consider being a scientist				

When I grow up I would MOST like to be: Indicate ONLY your TOP choice of Careers

Circle any of the following that you enjoy. (circle all that apply)

Science fiction movies/tv/books

Watching t.v. about science (like the Discovery channel or NOVA)

Reading Science magazines

Thinking/reading/talking about nature (planets, rocks, animals, human body)

Science class

Museums with science stuff (dinosaur bones, planetariums, laser shows)

Zoos

Bilim adamlarının videoları aracılığıyla STEM kariyerlerine olan ortaokul öğrencilerinin ilgisinin artırılması

Öğrenciler, ortaokulda STEM kariyerlerini takip etmedeki arzu ve yeteneklerini etkileyecek kararlar almaktadırlar. STEM kariyerleri (Bilim, Teknoloji, Mühendislik, Matematik) hakkında ortaokul öğrencilerine doğru bilgi sağlanması öğrencileri dersler ve kariyer seçimleri hakkında daha bilgili ve bilinçli seçimler yapmasına yardımcı olur. Öğrencilerin bilimin doğası ile ilgili kariyerleri anlamasına yardımcı olmalarını sağlayacak pratik yöntemler sınırlıdır. Dolayısıyla, bu çalışmanın amacı STEM kariyer imkânları hakkında öğrencileri bilgi vermek için STEM profesyonelleriyle video görüşme yöntemini incelemektir. İşlem ve karşılaştırma grubunun STEM kariyerlerini takip etmeleri ile alakalı öğrenci ilgilerini STEM profesyonelleriyle olan video görüşmelerin seyredilmeden önce ve seyredildikten sonra karşılaştırmak için ANCOVA analizi kullanılmıştır. Ortaokul çocuklarının STEM kariyerlerine olan ilgisinin video görüşmelerinden sonra artması bu metodun uygulanabilirliğini kanıtlamaktadır. Bu çalışmada STEM ile ilgili bir cinsiyet farkı tespit edilmemiştir.

Anahtar Kelimeler: bilimde cinsiyet, ortaokulda bilim, STEM kariyer seçimi, STEM’e olan öğrenci ilgisini sınıfta video kullanımı