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EXAMINING THE EFFECTS OF FIELD TRIPS ON SCIENCE IDENTITY

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ABSTRACT

The purpose of this work-in-progress study is to examine science identity of elementary school students in relation to participation in science. The questions asked in this initial analysis were: How will a field trip to a science research and learning center affect students' desires to learn and participate in science and does interviewing scientists alter this effect? A total of 151 elementary school (Grade 5) students (76 female and 75 male) participated in an experimental study. Participants were randomly assigned to two different experimental groups: 1) The experiment group attended the field trip and had the opportunity to meet and interview scientists. 2) The control group attended the field trip and did not meet and interview scientists. Results showed that all field-trip participants reported greater interest in their desire to become a scientist and participate in science after the field trip. Additionally, after the field trip, students who interviewed scientists were significantly higher in their desire to become a scientist than students who did not.

KEYWORDS

Role model, science identity, science participation

1. INTRODUCTION

How can we increase participation in science? A review of the literature provides an extensive list of factors thought to influence attitudes toward science. Determinants of who would like to learn science from a young age include gender, family, ability, youth culture, popular culture, education, support systems, personal interests, experiences, and time-use.

Interest in science has been related to how students feel about what they are studying, the learning environment, and concept of self (Bloom, 1976; Hurd, 1978). Opportunities to develop a sense of being *someone who does science* (Aschbacher et al., 2010) are considered important to science identity. Research on dimensions of science-related interest indicates that students' access, activity, achievement, and attitudes are key to interest in studying science (Hanson, 1996).

Additionally, participation and a place of learning are considered to be of interest to students' academic achievement and participation. Non-classroom activities are thought to enhance academic achievement (Campbell & Wolbrecht, 2006). Participation in science is generally related to a complex set of structural factors and contextual characteristics (McNeal, 1999). More specifically, participation in school extracurricular activities is thought to strengthen student ties to academic achievement, and opportunities for participation in science learning outside the school will provide additional opportunities for development of academic interests. Parents, mentors (formal and informal), heroes, and *adults of interest* have all been recognized for their influence on students' sense of self and academic achievement (Pleiss & Feldhusen, 1995). Finally, studies indicate that students express positive attitudes toward science when they experience success and receive support from others whom they consider to be important (Aschbacher et al., 2010). The current research presents an experimental study that was designed to compare the change in a student's desire to become a scientist between students who attend an out-of school science-related field trip with those who are randomly selected from the group to also meet and interview working scientists during the field trip.

2. CONCEPTUAL RATIONALE

2.1 Science Identity

Identity is comprised of components of adolescent development that serve to form identity for occupation and support the solidification of person in Super's (1980) life-span view of an articulated framework for vocational development. Merolla and Serpe's (2013) study of science-related enrichment programs and science identity among 654 graduate students reported that while gender, race, socioeconomic status, and psychological factors affect probabilities of girls entering a STEM profession. *Science identity* (or self concept) magnifies the influence of academic achievement on enrollment in graduate university programs. The success of STEM enrichment programs are thought to be intertwined with the social psychological process by which students may come to self-identify as scientists (Carlone & Johnson, 2007; Egan et al., 2012). Carlone and Johnson (2007) conducted an ethnographic study of science identity among successful women of color and reported that recognition of self as a scientist is an important component of success. Egan et al. (2012) drew from a study of 1,133 aspiring STEM college freshmen that emphasized the importance of the establishment of science identities at the earliest time. They reported that science identity promoted academic success by increasing the likelihood of participation in valuable activities and experiences, such as early research and time with professors, which would in turn nurture their STEM identities.

Aschbacher et al. (2010) suggest that it is important to provide students with opportunities to develop a sense of being someone who does science. Possible selves have been linked to academic achievement (Oyserman et al., 2006). Evidence suggests that the number of academic possible selves declines across the school years and that "Low income, rural and Hispanic youth are at risk of having few academic or occupational possible selves, or having such general possible selves in these domains that they are unlikely to promote self-regulation." (Oyserman & Fryberg. 2006, p. 1). It is therefore important to provide support for science interest to students in such at-risk populations.

Possible science selves are metaphors of self for being a person of science. Future possible selves are of particular interest as socially unverified aspects of being that are relatively impressionable components of self-regulation, motivation, and behavior (Markus & Nurius, 1986). Science selves are of interest for gauging student attitudes toward science liking, science learning, and participation. Smith (2006) examined possible selves in relation to expectancy theory and posited that possible selves are the driving force within self-concept that "should play a central, systemic role in the operation (self-regulation) of self-concept on a day-to-day basis" (p. 60) and can therefore play a key role in a student's participation in and learning of science.

2.2 Role Models

Sjøberg (2002) identified factors contributing to what he describes as disenchantment with science and technology (S&T) among young people today. He attributed the trend toward insufficient recruitment in S&T to contemporary youth culture within social and political phenomena that varies and is best described individually by country. Sjøberg offered a tentative list of rationale that relates to the larger social trends in participation in S&T. Three of the 13 items on his list relate to science stereotypes and role models: 1) The role models in many cultures are not employed in S&T. 2) Scientists and engineers are no longer heroes and are sometimes blamed for "evils of environmental degradation, pollution, global warming, etc." 3) Stereotypical images of scientists and are as follows, "Scientists (especially in the hard, physical sciences) are by pupils often perceived to be authoritarian, closed, bored – and somewhat crazy" (Sjøberg, 2002, p. 4).

A study that focused on providing middle school students with exposure to women in science found that students became more positive in their attitude towards scientists and the role of women in science after the exposure to women in science (Smith & Erb, 1986). It is suggested that teachers of science in the middle school/junior high grades should periodically bring community resource people who use science in their careers to the classroom to act as role models. Additionally, they recommended that all students should be included among the groups of professionals who visit students so that the attitudes of both male and female students toward scientists and women in science might be improved.

A review of the literature examining role models among gifted children reported gifted students benefited from relationships with successful adult role models and heroes within their areas of interest. They report that there are educational benefits for gifted children who have the opportunity to interact with and imitate behaviors of scientists (Pleiss & Feldhusen, 1995).

2.3 Participation in Science

A number of studies have focused on factors that create interest, encourage participation, and foster a sense of being someone who does science among young people. Research indicates that participation in science activities, such as library/museum visits, have a significant direct effect on science attitudes (George & Kaplan, 1998).

Persistence in continued participation on the science-related track is also an area of interest because many students who are initially interested in science eventually decide not to stay on the science academic path. Aschbacher et al., (2010) examined students' persistence in the science-oriented academic pipeline. They identified high, low, and lost groups by persistence, which were found to be different in terms of interaction and experience within three science communities: in school, outside of school, and within the extended family. Students who participated and found support for science in multiple communities were more likely to have science identities and to persist in science learning (Aschbacher et al., 2010). Persistent science interest and achievement has also been associated with having solid support for science interest at home, at school, and in extracurricular activities (Schneider & Stevenson, 1999).

2.4 Research Questions and Hypotheses

As previously mentioned, research indicates that participation in science learning activities outside of school can increase interest in learning science. Exposure to people of science (Smith & Erb, 1986) and receiving support for science interests, by people of interest, are both associated with the strengthening of science-related attitudes among young people (Aschbacher et al., 2010). Additionally, role models and adults worthy of imitating can influence students' sense of self and academic achievement (Pleiss & Feldhusen, 1995). Therefore, it is expected that students who attend the science field trip will become more positive in their self-concept for being a person of science. In addition, it is expected that students who also have the opportunity to participate in a small group discussion with and to interview scientists will have the most positive change in science attitudes as measured post experiment. In particular, the following hypotheses are proposed:

Hypothesis 1: Students who attend the field trip will be more positive in their perceptions of possible science self for *desire* to become a scientist pre-post field trip.

Hypothesis 2: Students who attend the field trip will be more positive in their perceptions of possible science self for *participation* in science-related activities pre-post field trip.

Hypothesis 3: Students who attend the field trip and meet/interview scientists will be significantly more positive in their perceptions of possible science self for *desire* to become a scientist after the field trip than students who only attend the field trip.

Hypothesis 4: Students who attend the field trip and meet/interview scientists will be significantly more positive in their desire to participate in science activities after the field trip compared to students who only attend the field trip.

3. METHODS

3.1 Participants

A total of N=151 primary school students took part in the study. The students who participated were enrolled in Grade 5 at a public school in the United States. Participants were almost evenly split by gender (76 girls and 75 boys). The participants in this study were part of a larger group of 324 students attending the field trip. Study participants were students for whom the following could be matched: 1) study permission slips, 2) pre-surveys, and 3) post-surveys. These participants were all from the larger field trip group, which comprised the entire 5th grade of one school district, excluding a small number of students staying back at their campus due to In School Suspension or because they failed to provide a field trip permission slip.

3.2 Measurement and Instruments

This study employed multiple methods to gauge students' science identity for being a person of science. The following instruments were administered to test participants' predispositions and changes of dispositions over time. These instruments were measured on a 5-point *Likert*-like scale with a response scale ranging from *strongly disagree* to *strongly agree*: 1) Possible Science Selves (PSS; 20 items; *desire* factor Cronbach's alpha=0.86; *participation* factor Cronbach's Alpha=0.80; Beier et al., 2012). 2) Creative Tendencies (13 items; Cronbach's Alpha=0.84; Mills et al., 2011). 3) Career Interest Questionnaire (12 items; Cronbach's Alpha=0.84; Bowdich, 2009).

The question items for the PSS factor for *desire* (hope) possible self are as follows:

- I have always hoped to have a job in science one day.
- Having a job in science one day is very important to me.
- I expect to go to college and get a degree needed for a job in science.
- It is very likely that I will get a job in science in the future.
- I expect to have a strong professional career in science in the future.

The question items for the PSS factor for *participation* (strategic) possible self are as follows:

- I want to take as many science classes as possible next year.
- If possible, I would get involved with a science club.
- If possible, I would want to attend a science camp.
- I would be interested in participating in a science fair.

In addition to participating in the experiment and completing surveys, students also drew a scientist and responded to open-ended response items to describe both a scientist and an engineer prior to attending the field trip. Preliminary findings from the field trip experiment are presented here.

3.3 Design

This is an early report from work-in-progress research on *Who wants to be a scientist?* conducted among students in primary school Grade 5. The relationship between an out-of-school science experience and science self-concept is explored. For the first phase of this study, students drew a scientist, listed characteristics of scientists and engineers, and completed pen and pencil survey instruments to provide responses to items of the PSS, Creative Tendencies, and CIQ instruments. These activities were completed at the students' home school. The experiment to test the effects of meeting and interviewing scientists was implemented during the field trip. Students participated in the various field trip activities in two groups: control and treatment. Approximately one-half of the students were selected at random to receive the treatment, which was meeting and interviewing scientists. The treatment group viewed an introductory movie, met/interviewed scientists, toured the working control room of the science facility (with scientists present), participated in hands-on science activities, and explored the interactive exhibit hall in the facility's science education center. The control group participated in the same activities; however, they did not meet/interview scientists. Instead, they met with a science educator who presented information on the research activities of the science facility and demonstrated aspects of physical science applied for the research. Students in the two groups were not aware of the difference in field trip activities.

The treatment group of students participated in 30-40 minute sessions, during which small groups of students (10-20 students per group) met and successively interviewed three science-related professionals who are employed in the research work of the field trip site. The science-related professionals who met with the students were both women and men of varying ages from a wide range of geographic locations. The topic of the interview session between the students and the science-related professionals was *becoming a person of science*. Students were provided with a script of suggested interview questions. Discussion was not limited to the scripted questions.

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3.4 Data Analysis

For each participant, initial (pre-field trip) Creative Tendencies and Career Interest Questionnaire scale scores were determined along with matched, paired pre-post PSS desire and participation scale scores. Data were examined by analysis of means procedures pre- to post-field trip and between control and treatment groups.

4. RESULTS

Paired samples *t*-test analysis was conducted to compare students' scientific self-perceptions for PSS desire and participation pre- to post-science field trip by control and treatment groups. Additionally, analysis of variance was conducted to compare differences between the experiment and control groups in PSS desire and participation factors post-field trip.

4.1 Pre-post Analysis

Control group analysis of *t*-test pre-post data (for students who attended the field trip only) revealed a significant difference (increase) on the academic *desire* PSS factor pre (M=2.53, SD=.939) and post (M=2.82, SD=1.04), $t(75)=-3.40$, $p=0.001$. This would be considered a small (0.291) Cohen's d (1992) effect size. A significant difference (increase) on the academic *participation* PSS factor pre (M=2.53, SD=1.02) and post (M=2.81, SD=.942), $t(80)=-2.84$, $p=0.006$ was also identified. This would also be considered a small (0.285) Cohen's d (1992) effect size.

Treatment group analysis of *t*-test pre-post data (for students who attended the field trip and met/interviewed scientists) revealed a significant difference (increase) on the academic *desire* PSS factor pre (M=2.59, SD=.870) and post (M=3.28, SD=1.16), $t(58)=-5.246$, $p<0.001$. This would be considered a large (0.668) Cohen's d (1992) effect size. Also, a significant difference (increase) on the academic *participation* PSS factor pre (M=2.50, SD=.771) and post (M=3.03, SD=1.13), $t(62)=-2.84$, $p<0.001$ was also identified. This would be considered a medium (0.553) Cohen's d (1992) effect size.

4.2 Experiment and Control Groups at Post-test

Analysis of variance, one-way between subjects ANOVA for post-test data, was conducted to compare the effect of meeting and interviewing scientists on PSS *desire* and *participation*. There was a significant effect as a result of the treatment on PSS *desire* at the $p<.05$ level for the two conditions [$F(1,138)=5.531$, $p=0.020$)] treatment and control. The mean score for the treatment condition (M=3.239, SD=1.172) was significantly different (higher) than the control condition (M=2.787, SD=1.045). This would be considered a small-to-medium (0.404) Cohen's d (1992) effect size. There was not a significant effect as a result of the treatment on the PSS *participation* factor at the $p<.05$ level for the two conditions [$F(1,145)=2.135$, $p=0.160$)]: treatment and control.

5. DISCUSSION

Student preferences, as the effect of liking science-related content, and student learning, as cognition, are separate yet related (Zajonc, 1980) aspects of students' attitude towards content areas such as science or STEM. These aspects are both elements of informal learning. Recognizing the importance of informal leaning to student attitudes towards STEM, this study examined participation in STEM activities that provide students with opportunities to interact with science-related content and to develop a liking for STEM in the real world—outside the classroom context. Positive science experiences, such as science field trips and exposure to interesting persons of science, will support positive attitudes towards science (Aschbacher et al., 2010; Pell & Jarvis, 2001). Preliminary findings from this study indicate that students' perceptions of being a person of science and their interest in doing science became more positive after a science field trip experience. This confirmation of students' more positive perceptions of being a person of science (one who will participate in science) as the result of an out-of-school science experience emphasizes the importance of providing students with opportunities to have these science-related experiences and also to feel supported in science interests in multiple communities (Schneider & Stevenson, 1999; Aschbacher et al., 2010). Additionally, results of the experiment showed that students who met and interviewed scientists in small groups were significantly more positive in their desire to become a scientist than students who did not have small group interaction with scientists — emphasizing the value of giving students the opportunity to see and meet role models (Smith & Erb, 1986).

Students will naturally aspire to imitate persons who are considered important, such as heroes and celebrities (Pleiss & Feldhusen, 1995; Sjøberg, 2002). However, there is some question as to whether or not scientists are considered to be important and interesting role models. In order to understand how students view STEM professionals, it is important to understand students' stereotypes of scientists. The stereotypes that students have of scientists have been previously examined through *draw a scientist* studies in order to allow an understanding of how people, especially children, picture scientists. Findings from this study support the notion that students who have the opportunity to become familiar with people of science (Smith & Erb, 1986) and have positive support for science-related interests by scientific role models whom they view as being interesting will have more positive science-related attitudes (Aschbacher et al., 2010). In addition to examining students' science self-concept after meeting STEM role models, participants in this study also drew a scientist. Study participants were found to be more positive regarding their science identities. Additional analysis is planned to compare the drawings of these students to other student groups in order to see if study participants differ in stereotypic views of STEM professionals from other student groups. The authors suspect that students who have the opportunity to meet scientists, as did the participants from this study, may tend to have less stereotypic depictions of STEM professionals. Additional research conducted by these authors will include the analysis of possible relationships between students' views of scientists and their own scientific identities. Ongoing research on factors that support science identity for participation in science is also suggested. The authors recognize that it will be difficult to gauge the long-term impact of informal learning activities, such as meeting scientists, being supported in science interests, and experiencing science-related field trips, will have on students. However, there is evidence to suggest that experiences that support a strong, positive science identity are not only related to younger students' interest and participation in science but are also related to persistence and success in attaining science-related academic goals as a part of students' higher education.

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