

They Choose to Attend Academic Summer Camps? A Mixed Methods Study Exploring Motivation for, and the Impact of, an Academic Summer Pre-engineering Camp upon Middle School Students in a Latino Community

Dr. Araceli Martinez Ortiz, Texas State University, San Marcos

Araceli Martinez Ortiz, PhD., is Research Associate Professor of Engineering Education in the College of Education at Texas State University. She leads a comprehensive research agenda related to issues of curriculum and instruction in engineering education, motivation and preparation of under served populations of students and teachers and in assessing the impact of operationalizing culturally responsive teaching in the STEM classroom. As executive director of the LBJ Institute for STEM Education and Research, she collaborates on various state and national STEM education programs and is PI on major grant initiatives through NASA MUREP and NSF Improving Undergraduate STEM Education and NSF DUE . Araceli holds Engineering degrees from The University of Michigan and Kettering University. She holds a Masters degree in Education from Michigan State and a PhD in Engineering Education from Tufts University.

Dr. Laura Rodriguez Amaya, Texas State University

Dr. Hiroko Kawaguchi Warshauer, Texas State University

Dr. Hiroko Kawaguchi Warshauer received her Ph.D. in mathematics education from the University of Texas at Austin in 2011. Her research interests include areas of teaching and learning that foster productive struggle and investigation of professional teacher noticing of student thinking at pre-service and in-service levels. She is co-author of the Math Exploration curriculum, a Texas Mathworks middle school textbook series state adopted in Texas and the Mathworks Junior Summer Math Camp curriculum. She provides professional development to support curriculum implementation. She is the Mathworks research coordinator, overseeing Mathworks related research about summer math camps, teacher training, curriculum, and classroom interactions with faculty and doctoral students in mathematics and mathematics education.

Mrs. Sara Garcia Torres M.Ed., Texas State University, San Marcos

Mrs. Sara Garcia-Torres is a PhD student at Texas State University and currently serves as a researcher for the LBJ Institute for STEM Education and Research. She supports NASA grant funded programs. She worked for public schools for the past 16 years as a bilingual and inclusion teacher, Gifted & Talented Facilitator, and as a STEM teacher. She works with educators, families, and community members to support STEM efforts in public schools, homes, and communities. Her research interests include STEM education, both the delivery to underrepresented students and the preparation of public school teachers. Holds degrees from Texas State University (M.Ed.), and University of Texas at San Antonio (BA).

Erin Scanlon, Texas State University

Erin Scanlon is an adjunct professor in the physics department at Texas Lutheran University as well as a doctoral student in developmental education at Texas State University. Her research focuses on curriculum and program evaluation as well as on STEM students' personal epistemologies.

Ms. Michelle Pruett, Texas State University

They choose to attend academic summer camps?

A mixed methods study exploring motivation for and the impact of a NASA academic summer pre-engineering camp upon middle school students in a Latino community

Abstract

Early exposure to engineering and mathematics career opportunities has been indicated to influence students' decisions regarding their academic majors and career goals. This study utilized mixed methods to analyze how changes in middle school students' affective characteristics might be linked to their future career decision-making after participating in an integrated science, technology, engineering, and mathematics summer camp. As part of the summer camp, rising sixth through eighth grade students attended a week-long learning experience based on a specific engineering context. Each grade level cohort participated with their same grade peers in a 36-hour, 6-day event focused on sparking their interest in engineering careers and on developing their content knowledge in select grade-appropriate science and mathematics content areas. Pre-post testing was conducted with sixty-five students of diverse backgrounds in grades six through eight to measure their self-reported engineering-related self-efficacy, knowledge of engineering careers, and motivation to pursue future engineering classes and careers. In addition, interviews were conducted to examine any changes in middle school camp participants' affective characteristics of motivation, self-efficacy, and self-determination.

Introduction

The attraction and retention of students in science, technology, engineering, and mathematics (STEM) disciplines along the full length of their education is a national imperative. Many efforts to improve STEM education have traditionally been targeted at high school aged

students, and while helpful, it is also important to motivate and prepare students at even younger ages. Elementary-aged students have the ability to understand and learn about engineering concepts, practices, and careers at a very young age. This learning can be further motivated when parents and teachers are involved in both formal and informal learning spaces. The emphasis of engineering at the K-8 level is critical to addressing the academic preparation challenges faced in college by students in STEM courses and responds to the prominent placement of engineering in the new Framework for K-12 Science Education (National Research Council, 2012). Additionally, effective instruction can reaffirm students' cultural, ethnic, and linguistic heritages (Jordan, Tharp & Baird-Vogt, 1992; Lucas, Henze & Donato, 1990), even in the context of STEM subjects.

Informal learning experiences are ones that take place outside of the formal classroom. For example, many informal learning experiences focus on science learning such as the educational experiences delivered by science museums, zoos, and hands-on children's museums. Some researchers (Bhattacharyya, Mead & Nathaniel, 2011) have found such experiences to make significant contributions as learning opportunities for student learners. Academic summer camps can fall somewhere in between informal learning and formal learning environments based on the setting, the instructional organization, and the curricula. In this study, the STEM summer camps take place in a classroom setting, instructed by teams of teachers, but the curriculum is a uniquely designed learning program that integrates NASA scientific contexts with grade appropriate algebraic concepts as part of exciting hands-on engineering design activities. The design of the summer camps in this study (*NASA science and algebra summer camps*) is based on prior studies that have explored the impact of the summer camp learning experience on students' career awareness and interest in STEM fields. Martinez Ortiz et al. (2015) presented a summer program for underrepresented students in STEM that was purposefully designed to integrate green energy

concepts and engineering design. Findings indicated that the camp experience was indeed informative in clarifying students' understanding of the field and increasing career interests. Other STEM summer camp program studies have shown how these type of experiences have increased student motivation and interest for careers in STEM fields (Mohr-Schroeder et al. 2014).

The *NASA science and algebra summer camps*, which will be further described in the following sections, offered early space-based STEM learning experiences for upper elementary and middle school students, bilingual outreach initiatives for their families, and professional development for the teachers who served as camp instructors. The consistent curricular framework for these camps was grade-appropriate and standards-based with a distinct space theme and an underlying framework focused on algebraic reasoning and engineering problem solving and design. The overall summer camp program was a no-cost six day camp organized by grade level for student teams of up to 15 participants from third to eighth grades. This study will report on the experiences of participants in these camps, changes in their self-reported motivation, self-efficacy, and self-determination regarding STEM skills, and connections to career aspirations.

Importance of Algebraic Reasoning

According to the 2005 National Assessment of Educational Progress (NAEP, 2005) results, the discrepancy in scores between White and African American eighth-grade students as well as those between White and Latino eighth grade students has persisted over the last ten years (Loveless, 2008; NAEP, 2008). This is concerning, since mathematical literacy, in general, is considered to be a critical factor or gateway for students and is linked to college readiness and success in higher education, careers, and social stability (Allestaht-Snyder & Hart, 2001; Chazan, 2000; Moses & Cobb, 2001). Algebraic reasoning is one of the mathematics learning strands

supported by standards in most states for children in grades K-12. In essence, teaching students to develop skills in algebraic reasoning means that students are taught the various topics of mathematics, including number sense and numeric operations, in a deeper way that requires a higher level of critical thinking. By familiarizing students with some abstract algebraic ideas applied in realistic, engaging contexts, students learn more deeply and perform better in the mathematics classroom (Brizuela & Earnest, 2008).

The *NASA science and algebra summer camps* are guided by principles of constructivist learning theories (Piaget, 1965), social constructivist theories (Vygotsky, 1978), and constructionist approaches (Papert, 1980). Piaget's constructivist learning theory proposes that children construct their own knowledge through active physical and sensory experiences leading them to construct and organize patterns of ideas (logico-mathematical knowledge) and through social experiences (social-conventional knowledge; Piaget, Henriques, & Ascher, 1992). The activities utilizing design in engineering education serve as a potential context for providing the kinds of experiences Piaget alluded to in his research, as these experiences allow the learner to actively engage in his or her own learning process, reflect on the use of existing structures of knowledge, and benefit from scaffolded learning in an environment that values participation and interaction among students, teachers, and other resources (deMiranda, 2004; Loewenberg Ball, 2010).

Engineering Problem Solving & Design as Context

Curricular units and engineering activities have been successfully developed and introduced in elementary classrooms and in secondary mathematics and science classrooms. Wong and Brizuela (2006), in a series of hands-on investigations for middle school students, offer

integrated engineering design activities in which students collect and analyze their own mathematical data while considering real-world situations. These research-based activities allow students to develop algebraic thinking skills in engineering-integrated contexts.

Research has indicated that engineering curriculum and instruction in the kindergarten to the twelfth grade classroom can serve as a vehicle to teach other content areas in a cross-curricular fashion (Martinez Ortiz, 2011). For example, certain engineering curricula have been found to impact learning in the specific content areas of mathematics and science. The National Science Education Standards and Benchmarks for Science Literacy (AAAS, 1993) and now the Next Generation Science Standards (2013) call for a learning environment that is student-centered and engages students in asking their own questions and designing experiments to solve problems. They also call for students to make physical system models that demonstrate their learning and understanding. K-12 engineering education experiences may facilitate meeting these objectives, and efforts have already resulted in novel curricular approaches that include formally structured activities and learning objectives guided by state curricular standards in mathematics and/or science (American Association for the Advancement of Science, 1993).

In addressing the numerous factors that contribute to unequal participation of minorities in science education, many are in agreement that early exposure to STEM careers is essential (Heckman, 2006; Kazakoff, Sullivan & Bers, 2013; Nadelson, 2013). Throughout the last decade, researchers have recommended that career exploration and awareness begin before high school (Castellano et. al, 2002; Fouad, 1995; O'Brien, et. al, 1999). A study using nationally representative longitudinal data suggests that to attract students into the sciences and engineering, close attention should be paid to children's early exposure to science at the middle and even earlier grades (Tai et al, 2006). The concept of elementary school career education has gained momentum in recent

years. According to Ediger (2000), “the elementary school years are not too early to begin to achieve a vision of what one desires to do in life contributing to the world of work” (p.1).

Community partnerships are mentioned by career education experts as one of the “tools” that can increase students’ awareness of their own interests and help them learn about a wide variety of occupations (Hogan, 1995). Furthermore, research on cultural-historical factors and their influence on Latino student educational success points to community as a particularly important element (Goldenberg, Reese, & Gallimore, 1992). The NASA science and algebra summer camps included a strong community partnership element and featured a career awareness component by exposing young children to role models from various NASA digital resources, Engineering is Elementary storybooks (Cunningham et. al, 2005), as well as local Latina/o speakers who are professionals in the STEM fields. It is indeed powerful for children to hear from someone who looks like them and learn from their story, their journey, and their career. It is expected that exposing children to STEM careers at a young age and over a period of a year or more will reap enormous benefits for participating individuals. Such career awareness experiences are essential for students to learn the skills they need to succeed in the 21st century.

Standards Aligned Curriculum

Alignment of curricula across disciplines from grades K-12 through the integration of mathematics, science and the engineering process has been recognized as a way to improve STEM education (Dushl et al., 2007). The curricula designed for the summer programs are aligned to the Texas Essential Knowledge and Skills (TEKS) and the Common Core State Standards for Mathematics. Teachers who serve in the summer camps as camp co-leads also participate in professional development opportunities designed specifically to prepare them for the objectives of the summer camps. At the summer camp professional development sessions, teachers receive

training on the curriculum, instructional strategies and research regarding best practices in STEM education. The purpose of the professional development sessions and teacher participation in the summer camps is to give teachers the tools to effectively implement STEM education in their summer classrooms and possibly into their academic year classrooms as well. The resources shared with teachers at the summer camps can easily be implemented and adapted to their teaching environments.

METHODOLOGY

Context of study.

The *NASA science and algebra summer camp* participants in grades three through eight received 36 hours of instruction in integrated algebraic reasoning, science, and engineering design. This study focused on the six day middle school summer camps (sixth through eighth grades). The themed sessions for the camps were robotics for sixth grade, life in space for seventh grade, and rocketry for eighth grade. This study employed a mixed-methods approach to analyze how changes in middle school students' affective characteristics might be linked to their future career decision-making after participating in an integrated STEM summer camp. This article focuses on participants' responses to the Engineering Motivation Questionnaire (EMQ, adapted from the Science Motivation Questionnaire ii; Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011), Middle School Students' Attitude to Mathematics, Science, and Engineering Survey (MSE; Gibbons, Hirsch, Kimmel, Rockland, & Bloom, 2004) along with participants' responses to post-intervention interviews.

Study participants.

Sixty-five students participated in the *NASA science and algebra summer camps* of which a total of 52 participants' pre and post data was matched. Demographics presented represent only

the 52 matched records. Participants were rising sixth through eighth graders from local middle schools. Data shows that 35% were female and 65% were male. As represented in Table 1, as the grade level increased the number of girls decreased. The ethnic makeup of the participants reflected the demographics of the local school district with 56% Latino participants , 27% White participants, 5% African-American participants, and 12% Other.

Table 1

Demographics of summer camp 2016 participants by Grade Level

	Female	Male	Latino	White	African American	Other
Grade Six	52.9%	47.1%	76.5%	17.6%	5.9%	0.0%
Grade Seven	27.8%	72.2%	55.6%	22.2%	5.6%	16.6%
Grade Eight	23.5%	76.5%	35.3%	41.2%	5.9%	17.6%

Data collection.

Data collection took place at the beginning and at the end of the six day middle school summer camps. Quantitative data was obtained through the administration of pre and post surveys. Pretest surveys were administered on the first day and post tests were administered on the last day of instruction of the camp (the last half day of the camp was devoted to participants’ presentations of their work). The following three measures were administered to the participants: 1) Iowa Algebra Aptitude Test (IAAT, 2006), 2) Engineering Motivation Questionnaire (EMQ; Glynn, Brickman, Armstrong, & Taasobshirazi, 2011), and 3) Middle School Students’ Attitude to

Mathematics, Science, and Engineering Survey (MSE; Gibbons et al., 2004). The results of the EMQ and MSE will be explored further in this article.

Qualitative data was obtained through one-on-one, semi-structured interviews with summer camp participants at the end of each summer camp session. These interviews probed participants' understanding of the mathematics, science, and engineering concepts covered in the camp along with their attitudes and beliefs about engineering and engineering careers. Researchers and camp staff trained on implementation of the camps-specific interview protocols conducted the one-on-one interviews with camp participants which averaged 20-30 minutes in length. After data collection, each participant was assigned a unique identifier and the data corpus was anonymized.

Data Analysis

Quantitative.

Engineering Motivation Questionnaire (EMQ).

The Engineering Motivation Questionnaire (EMQ) was adapted from the Science Motivation Questionnaire ii (SMQii; Glynn, Brickman, Armstrong, & Taasobshirazi, 2011). The word 'science' in the original SMQii was replaced with 'engineering'. The EMQ was administered to 67 students. 48 participants, matched by a unique identifier, had both pretest and posttest surveys. Only these 48 records were used for the data analysis of the EMQ results. This survey probed students on the constructs of motivation and self-efficacy along the following components: intrinsic motivation, self-efficacy, self-determination, grade motivation, and career motivation. Each question had three collapsed categories ranging from zero (I Don't Know), one (Disagree), and two (Agree). A scale score for each component mentioned previously was calculated by

averaging the scores of the questions that probed that component. Therefore, each component scale score ranges from zero to twenty, with a higher mean being desirable.

Middle School Students' Attitude to Mathematics, Science, and Engineering Survey (MSE)

The MSE (Gibbons et al., 2004) was also used to investigate participant attitudes. Sixty-three records, matched by a unique identifier, had both pretest and posttest surveys. Only these 63 records were used for the data analysis of the MSE results. The survey probed participants' knowledge of engineering careers, exposure to engineering careers, and attitudes and beliefs about engineering. The MSE probed along the following six components: Interest-Stereotypic Aspects, Interest-Non-Stereotypic Aspects, Positive Opinions, Negative Opinions, Problem Solving and Technical Skills. Each component included a varying number of questions. Consequently, the scale score for each component was calculated by adding up participants' scores for all questions within a component and dividing it by the number of questions. Therefore, each components' scale score ranges from zero to two.

To determine whether there were any significant changes in students' responses in both the EMQ and the MSE, a paired t-test and a Cohen's *d* test were conducted using the IBM SPSS statistical application. For pre-post design data analysis of numerical data a paired t-test was used as the simplest form of analysis to determine statistically significant results (Arifin, 2014). Running paired t-tests is an analytical technique that can be used for normally distributed data and large sample sizes are not required. The most commonly used critical value for the t-test is .05 or less. The Cohen's *d* is an effect size that accompanies the reporting of the t-test and was conducted to determine the practical significance of the EMQ and the MSE results for statistically significant findings. The relatively low number of participants can artificially deflate the statistical

significance and therefore the practical significance was also calculated. As a general guideline, a value of Cohen's d below 0.20 is considered small, 0.50 medium, and 0.80 large (Cumming 2012).

Qualitative.

We used qualitative methods to examine changes in middle school camp participants' motivation, self-efficacy, and self-determination which may be linked to career decisions and course choices in their future. The qualitative findings were based on the transcripts of 53 interviews of sixth through eighth grade camp participants as conducted during the last two days of the summer camp. There were 17 participants in sixth grade, 19 participants in seventh grade and 17 participants in eighth grade who were interviewed. Each interview lasted approximately 20-30 minutes and was conducted one-on-one with a participant and a researcher. Each interview included both a clinical task portion and an affective characteristic portion. For the purposes of this study, only the affective characteristic portion is reported.

In order to analyze text data of the interviews of the participants, a qualitative content analysis technique referred to by Hsieh & Shannon (2005) as *directed content analysis* was used. While content analysis in general interprets meaning from the texts of the data, the directed content analysis in particular, "starts with a theory or relevant research findings as guidance for initial codes" (p. 1277). The research team was informed by studies in motivation, self-efficacy, and self-determination to guide the analysis of the interview texts.

The following are the working definitions for the qualitative analysis conducted.

Motivation "is an internal state that arouses, directs, and sustains students' behavior. The study of motivation by science education researchers attempts to explain why students strive for particular goals when learning

science, how intensely they strive, how long they strive, and what feelings and emotions characterize them in the process." (Glynn & Koballa, 2006)

Operationalized for middle school students, the middle school participants' reasons for "wanting to" do something were investigated.

"Self-Efficacy is a person's belief about his or her capabilities to produce designated levels of performance that exercise influence over events, e.g., accomplish or succeed in a task or situation" (Bandura, 1997). Operationalized for middle school students, participants' words were investigated for when they felt they "could" do something. "Self-Determination "is the ability to have choices and some degree of control over what we do and how we do it." (Reeves, Nix, and Hamm, 2003). Operationalized for middle school students, instances where participants had decided they "would" do something were investigated.

Quantitative Findings

Participants' pretest and posttest responses to the Engineering Motivation Questionnaire (EMQ) and Middle School Students' Attitude to Mathematics, Science, and Engineering Survey (MSE) were collected at the start and end of the summer camp program (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011; Gibbons et al., 2004). Table 2 displays participants' pretest and posttest scores along with results from t-tests comparing the pretest and posttest scores.

Table 2*EMQ Responses and t-test Results (n=48)*

	Intrinsic Motivation	Self-Efficacy	Self-Determination	Grade Motivation	Career Motivation	Overall
Pretest M (SD)	13.19 (4.077)	15.19 (3.648)	12.42 (4.292)	14.35 (4.045)	14.52 (4.000)	69.67 (16.753)
Posttest M (SD)	13.92 (4.404)	15.29 (3.946)	12.98 (5.349)	14.67 (4.982)	14.82 (4.088)	71.67 (19.126)
t (df)	-1.92 (47)	-0.26 (47)	-1.35 (47)	-0.67 (47)	-0.60 (47)	-1.33 (47)
p	0.061	0.799	0.185	0.507	0.553	0.189
Cohen's d	0.172	0.026	0.115	0.071	0.072	0.111

Note: Items were phrased such that a higher mean is more desirable.

The participants' pretest scores were not statistically ($p < 0.05$) or practically (Cohen's d greater than 0.5) different from the posttest scores on any of the five subscale measures or overall. Differences in scores between the genders were also not statistically or practically significant ($p < 0.5$).

The Middle School Students' Attitude to Mathematics, Science, and Engineering Survey (MSE) probed participants' attitudes and beliefs about engineering and engineering careers along six components. Table 3 shows each MSE component's scale scores and t-test results.

Table 3*MSE Responses and t-tests Results (n=63)*

	Interest: Stereotypic Aspects	Interest: Non-Stereotypic Aspects	Positive Opinions	Negative Opinions	Problem Solving	Technical Skills
# of Questions	7	4	4	6	3	3
Pretest	1.10	1.14	1.09 (0.61)	1.02 (0.22)	1.30 (0.68)	1.34

M (SD)	(0.51)	(0.57)				(0.56)
Post test M (SD)	1.12 (0.53)	1.13 (0.62)	1.14 (0.60)	1.05 (0.25)	1.32 (0.70)	1.34 (0.63)

Similar to the EMQ results, the pretest scores were not statistically ($p < 0.05$) or practically (Cohen’s d greater than 0.5) different from the posttest scores on any of the six subscale measures. This shows similar results between the two measures. Participants’ motivation was probed more deeply by analyzing their responses to open-ended questions (presented in the Qualitative Findings section).

The MSE survey also asked participants to rank how many times they had heard about engineering careers from multiple sources. The sources included television and movies, friends, personally from their teachers, teachers to the whole class, parents and/or guardians, and school counselors. Participants were asked to rank the number of times they had heard about engineering careers on a scale where zero is equivalent to ‘never’, one is equivalent to ‘1-2 times’, and three is equivalent to ‘many times’. Table 4 shows the average responses from participants along with a comparison of participants’ pre and posttest scores (t-tests).

Table 4

Who Talked to the Participants about Engineering Careers Responses and t-test Results

N=63	TV Movies	Friends	Teachers (Personal)	Teachers (Class)	Parents	Counselors
Pretest M (SD)	1.40 (0.64)	0.68 (0.62)	0.68 (0.80)	0.97 (0.72)	1.11 (0.76)	0.41 (0.64)
Post test M (SD)	1.19 (0.59)	0.73 (0.67)	0.65 (0.72)	1.03 (0.72)	0.95 (0.77)	0.35 (0.63)

t (df)	2.51 (62)	-0.60 (62)	0.39 (62)	-0.63 (62)	2.45 (62)	0.94 (62)
p	0.015 *	0.553	0.698	0.531	0.017 *	0.350
Cohen's d	0.35	0.08	0.04	0.08	0.21	0.09

* Statistically significant. Higher mean implies more times heard about engineering careers.

Participants' responses were statistically significantly different at pre and posttest for TV/Movies ($t(62) = 2.51, p = 0.015$) and Parents ($t(62) = 2.45, p = 0.017$). Focusing on the parental difference, this implies that parents talked with participants significantly more by the end of the camp than at the start of the camp. This shows a positive effect of the camp on the participants and their families.

Qualitative Findings

In order to decrease bias and to minimize variability in interpretation of the codes, we chose a small sample to code prior to coding the entire 53 transcripts. For the purposes of inter-rater reliability and determination of coding consensus of the affective characteristics, three of the researchers independently coded 9 of the 53 interview transcripts. Three transcripts were randomly chosen from each grade level. We were able to reach agreement on our codes before coding the remaining 44 transcripts.

In the following section, the findings are broken down by the three characteristics and participant quotes are provided to illustrate how the participants expressed the effect the camp had upon them in terms of each affective characteristic.

Motivation.

Camp participants reported how excited they were to conduct projects and experiments which they worked to create but had fun at the same time: "Playing with Legos (is my favorite

part), because I get to create things. I love creating things.” This seventh grade participant recognized the need to use their brain to be innovative: “I feel like not just to be smart, but to be healthy, to be strong [*sic*]. It isn’t all about the brains. Most of it’s the brains, otherwise who’d come up with NASA and stuff like that.”

An eighth grade participant reported, “I was already thinking about it (a STEM career) but I think it made me for sure that I want to be an engineer later on [*sic*].” The participant enjoyed the rocket launch experiment, as (s)he reports, “I think it was just really fun to launch them (rockets) because my group worked really well, and I was just proud that I built something like that.”

A sixth grade participant was surprised that engineering could be so much fun or that there were so many kinds of engineers. (S)he says, “I thought it (camp) was so much fun and so not thinking that my job in the future would be fun, because, I want to be a robotics engineer.” Another sixth grader hadn’t previously known about engineering careers, as related in the interview, “I didn’t really know what engineers do much before and now that I do, I really want to become one. The one I like the most is environmental engineering.”

In summary, the camp provided a setting for participants to experience science, engineering, and mathematics learning creatively while working within a friendly team structure. Some participants were surprised that these projects were related to bigger projects that involve engineers in the real world and reported considering career options along these lines.

Self-efficacy.

Many of the participants mentioned that they were confident in their mathematics and science abilities. The following is an example stated confidently by a sixth grader: “I’m great at math, and I like it!” Others expressed the desire to take advanced math classes as this eighth grade

participant stated, “I already do [take advanced math classes], so I was planning on it, to still do that.” While their sense of confidence in mathematics and science may not be completely attributable to their *NASA science and algebra summer camp* experience, the camp may have contributed to build their sense of efficacy even more as they challenge themselves in new settings.

Other participants felt greater confidence in their ability to independently design and build some of the objects that they had built at camp. One eighth grade participant was asked if (s)he could build a rocket - to which the participant replied, “On my own, yeah!”

In summary, most of the participants seemed to feel very confident in their mathematics and/or science abilities and reported affirmatively that they would challenge themselves with advanced courses in their future schooling.

Self-determination.

Using the working definition of self-determination as the “...ability to have choices and some degree of control over what we do and how we do it.” (Reeves, Hamm, and Nix, 2003), we observed participants who would choose to take advanced math and science courses or would join a STEM club. An eighth grader indicated that a path towards a STEM career involved an “...attempt to get the highest grades you can, and then just- and do lots of extracurriculars, depending on which kind- which field you want to go into, and research the best college for whichever field that you want [*sic*].”

Others were weighing their career options and reported becoming more certain of their choice. When asked what kind of career they were considering, one sixth grader reported, “Scientist maybe. I’m still holding on to what I’ve wanted to be since I was like 5.”

In summary, the participants had a sense that the path towards a STEM field would involve intense study, college, and learning about science and math. Their determination seemed palpable

as stated in the words of a sixth grade participant, "...you need to go with your goals, and stick to them, until you've passed it, and go for greater, like foremost and beyond."

Discussion

The constructs of motivation, self-efficacy, and self-determination of *NASA science and algebra summer camp* participants were measured quantitatively and qualitatively. Participants' responses to the EMQ and SME did not show significant differences in participants' intrinsic motivation nor in their interest in engineering careers over the course of the camp. One factor that may have affected these quantitative results is methodological- regarding the timing and method of data collection. It is often challenging to motivate students to participate as enthusiastically in the data collection aspects of a program, as in the program activities. During the first and last days of the summer camp, participants were asked to complete both the EMQ and the SME. Compared with the entertaining and exciting engineering activities of the summer camp, the participants found the pre-post testing to be significantly less enjoyable. This could have affected the participants' performance on the pre-post testing due to lack of commitment to reading and answering the questions on the surveys accurately. This is an area of opportunity for improvement and shorter survey sections will be administered in the future.

Although no statistically significant differences were found among the participants' pre and post responses to motivation or career decision making, the interview data provided qualitative evidence that participants' experiences during camp did indeed impact their outlook towards engineering and other science, technology and mathematics careers. While research about children's career development is limited (Watson & McMahon, 2008; Porfeli, Hartung, & Vondracek, 2008), the qualitative study by Rowan-Kenyon, Swan, & Creager (2012) examined

social cognitive factors, support, and engagement of early adolescents' math interests as precursors to career choices. Their findings indicate that using group work and extrinsic motivation in middle school math classes broadened interest. This is consistent with our findings across the three middle school grades that show that the camp projects where participants worked together in groups, were challenged to think creatively and collaboratively, and experienced the joy of successful rocket launches or responsive robots could now be viewed as part of the work of being an engineer. This also provided motivation for participants to consider engaging in such “fun” projects with an eye towards future careers as engineers and scientists.

Participants' responses to the EMQ and SME did not show significant changes in participants' self-efficacy over the course of the camp. Therefore, participants' responses during qualitative interviews were investigated to further understand participants' self-efficacy. From our interview findings, we determined that due to self-selection, many of the participants arrived at camp with an existing high sense of self-efficacy. For example, when asked about their confidence in succeeding in the advanced math classes, participants across grades were generally confident in their ability and inclination toward taking the advanced math and science classes offered in their schools. The summer camp opportunities that invited participants to perform and complete specific tasks, particularly as group projects, further reinforced their v perceptions of their ability to persist. For example, research by Britner and Pajares (2006) found that participants' mastery experiences were the only statistically significant predictor of science self-efficacy.

Similar to motivation and self-efficacy, statistically significant differences in participants' self-determination were not found. Our qualitative data provided evidence that the camp raised an awareness of requirements for pursuing a STEM career such as entrance into college, as a seventh grader indicated that (s)he was “going to try a little bit more harder” and an eighth grader voicing

his/her intent to “pick the best college...and learn about engineering or to become one.” Another eighth grader planned to work harder and participate in science projects to learn more about science so that (s)he can become a scientist. In light of research showing that academic intrinsic motivation decreases from grades three through eight (Lepper, Corpus, & Iyengar, 2005), the opportunities provided at the summer camp suggests such informal, out-of-school experiences may help to increase rather than decrease motivation and self-determination of its participants. Future studies will involve following these students longitudinally to measure sustained interest, record academic choices taken and to administer post-post responses to the same surveys and constructs.

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