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Teacher Influence on Elementary School Students' Participation in Science, Technology, Engineering, and Mathematics

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ABSTRACT

The purpose of this study is to explore the influence of elementary school teachers on encouraging students' interest and participation in Science, Technology, Engineering, and Mathematics. The researcher sought to understand what methods teachers use in their classrooms to encourage students to participate in STEM subjects and programs. This mixed methods study consisted of a questionnaire to collect quantitative data, as well as an interview of selected teachers who participated in the questionnaire to collect qualitative data. The data was analyzed to determine the overall perceptions of teachers regarding the importance of encouraging students to participate in STEM. The qualitative interview process was then used to explore in more detail what specific methods the teachers implemented to encourage students to participate in STEM. Results of this study suggest that the participants strongly agreed that it was important for students to be interested in STEM subjects and for teachers to encourage students' interest in STEM subjects. However, the teachers did not as strongly agree in their abilities to effectively teach STEM content or make it fun and engaging for the students. This showed that the teachers' belief in encouraging students to participate in STEM was more highly rated than their feeling of efficacy in teaching and engaging the students in STEM. The qualitative portion of this study revealed strategies used by veteran teachers who increased their teaching and engaging students in STEM subjects at the elementary level.

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Introduction

Despite the fact that females are earning high school math and science credits at the same rate as males, and are earning slightly higher grades in these classes (Mosatche, Matloff-Nieves, & Kekelis, 2013), a significantly lower percentage of females than males are entering fields of science, technology, engineering, or mathematics (STEM), and even fewer are earning degrees in those fields (Hill, Corbett, & St. Rose, 2010). As indicated by the higher grades females received in the high school math and science classes, as well as the fact that women have successfully pursued STEM fields previously, females have proven themselves capable of becoming knowledgeable, literate, and prosperous in these areas. These facts beg answers to the following question, if females possess the mental capacity to pursue these fields, then why are not many more females pursuing STEM fields? Furthermore, what influence do teachers and educational experiences have on a student's decision to pursue STEM?

Many studies have been conducted on the gap between men and women involvement in STEM subjects and fields from the time they are in middle school through the time they have established their careers, to try and determine what affects a woman's choice for, or against, a major and/or career in science, technology, engineering, or mathematics. When examining why women chose not to pursue a STEM field, research by Hill et al. (2010), Mosatche et al. (2013), and Zeldin and Pajares (2000), resulted in three reoccurring factors: 1) women maintained a lack of confidence in their abilities to succeed in areas involving STEM, 2) women had a general lack of interest in the topics, and 3) teacher or mentor influence could be a determining factor in their decision. A study conducted by Zeldin and Pajares (2000), went in depth to explore

specifically how the self-efficacy of women affects their decision to enter a STEM field. They found that "women...seem to need more persuasion from at least one person, usually a teacher, to attend graduate school" (p.219), and that the women who had obtained a bachelor's or master's degree in mathematics had "individual mentors who were instrumental in helping them develop their interest" (p.220).

Extensive amounts of literature and research are currently available regarding the topic of the lack of women in STEM fields, and have established several facts that will be helpful in researching the topic of teacher influence in student's decision to participate in STEM. Studies such as the one conducted by Hill et al. (2010), established that women have the mental capability to succeed in STEM classes and often perform better, in regards to grades, than their male counterparts. Mosache et al. (2013) showed that through programs that involve "hands-on projects, career exploration, and academic and career guidance in science and engineering" (p. 18), adolescent girls can develop interest in STEM fields. The research found by Zeldin and Pajares (2000) confirmed that teachers and mentors play a vital role in directing students to STEM. However, despite these findings and all the research on the topic, most of the subjects studied are between adolescent and adult years, and very little research has been conducted on female students in elementary school. What remains to be explored is how teachers in an elementary school setting influence their students in a positive or negative way regarding STEM subjects.

Although the significant lack of women in STEM may not seem to be imperative, or even a problem, research suggests that women are vital to the STEM workforce. According to Hill et al. (2010), the expansion and development of STEM is considered to

be a crucial issue to the national economy and government, and encouraging women to join the STEM workforce will maximize innovation, creativity, and competitiveness. It is important for women to be a part of the STEM workforce for many reasons, including that the presence of gender diversity in the workplace provides a greater range of perspectives and viewpoints that help to insure the products and services will incorporate the needs and desires of both male and female customers (Hill et al., 2010). Because women are so valuable in the STEM workforce, it is necessary that they be encouraged and receive support in pursuing those fields, and according to Zeldin and Pajares (2000), teachers are one of the most influential factors in that decision. Conducting a study on the influence of teachers in elementary schools is significant because it will give insight to how students are being encouraged or persuaded in their foundational years of learning.

Purpose of the Study

The purpose of this study is to explore the influence of elementary school teachers on engagement of student interest and involvement in Science, Technology, Engineering, and Mathematic programs or activities. Additionally, this study sought to understand what methods teachers use in their classrooms to encourage students to participate in Science, Technology, Engineering, and Mathematic subjects and programs. For the purpose of this study, elementary school teachers' influence will be generally defined as the guidance and encouragement, or lack thereof, that teachers provide to their students regarding participation in Science, Technology, Engineering, and Mathematics.

Research Questions

Pursuant to the purpose of the study, the following research questions will guide this study:

(a) What are the perceptions of elementary school teachers on engaging students' interest and participation in STEM?

(b) What methods, if any, do elementary school teachers use within their classrooms to encourage students to participate in STEM?

Review of Literature

A review of current literature was conducted on articles and research involving students' interest and decision to pursue science, technology, engineering, and mathematics (STEM), in an attempt to explore what influence teachers, specifically elementary school teachers, had on the students' decision. Through the review of the literature, there were three topics or themes that were commonly found throughout research. The first topic involved factors that influence a student's decision to participate in STEM (Hall et al., 2011; Lawrence & Mancuso, 2012). Another topic mentioned in the majority of the literature involved females' lower level of interest in STEM, and the lack of women who pursue a career in those fields ((Hill, Corbett & St. Rose, 2010; Mosatche, Matloff-Nieves, & Kekelis, 2013; Zeldin, Britner, & Pajares, 2006). The third topic addressed in the literature was different methods to encourage students, especially females, to become interested and participate in STEM (Reis & Graham, 2005; DeJarnette, 2012; McCrea, 2011). These three topics and the relevant information gathered from the literature are discussed in the following literature review.

Factors that Influence Students' Decision

When examining the literature on factors that influence students' decision to pursue STEM, teachers were found to be one of the highest rated influences. Hall et al.

(2011) conducted a study to determine what factors influence students' choice to pursue STEM fields. They surveyed one hundred eighteen high school students from age 12 to 18, freshman to senior year (three students were eighth graders who would be entering the ninth grade), and included 63 female students and 55 male students. The students' races included American Indian, African American, Pacific Islander, Asian, Hispanic/Latino, Caucasian, and other. The students were given a two-part questionnaire (part A and B) to determine what the students considered to be influential factors. Part A of the questionnaire conducted by Hall et al. (2011) focused on career choices and students' interest in career options. The result showed that students included friends, peers, parents, teachers, counselors, media, degree options, earning potential, and affordability of college program as factors of influence. However, the top four considerations in career choice were their interest in a field, their parents' influence, earning potential, and teachers' influence. Part B asked students to rate factors such as friends with similar interest, family members in a particular field, teacher encouragement, and school faculty who were knowledgeable about different career options on a scale from 1 (not important) to 5 (very important). This portion of the questionnaire revealed that faculty who were knowledgeable about different career options was the highest rated influence, and teacher encouragement was the second highest. The results of the study conducted by Hall et al. supported the fact that teachers are an influential factor in students' career choice, and revealed that students considered teacher encouragement to be very important to their decision (2011).

Lawrence and Mancuso (2012) discuss ways for teachers to encourage middle and high school females in pursuit of interest in the subject of engineering, specifically a

program called Girls Excited about Engineering, Mathematics, and Computer Science (GE2McS), and how participation in programs such as this can influence a students' decision regarding participation in STEM. The program was designed to encourage females to participate in STEM fields as well as increase the female students' awareness of career opportunities in those fields. Over a seven year time span, a survey was conducted on 509 of the students that participated in the GE2McS program. Students were questioned on their satisfaction with the program and were asked to provide a rating of this on a scale of 1 to 5. The results of the survey showed that the average rating received was 4.34 out of 5. Data collected on the students that attended the GE2McS program showed that "18.6% of GE2McS participants enrolled in engineering in college, compared to the national figure of only 8%."

Underrepresentation of Women in STEM Fields

The current literature focused a great deal on the underrepresentation of women in STEM fields, and several studies were conducted to try and determine which factors may cause women to decide against pursuing STEM fields when choosing their career. The article by Hill, Corbett, and St. Rose (2010), addresses the question of why so few women are represented in the science, technology, engineering, and mathematics fields. According to Hill et al., "Girls are earning high school math and science credits at the same rate as boys and are earning slightly higher grades in these classes" (p.3). However, females continue to be outnumbered in the fields of STEM. The article examines the different reasons why females choose against STEM in middle through high school, college, and in the workplace. It also provides many statistics regarding factors that show a gender difference: the SAT, ACT, and AP exam scores, the subjects that students chose

to take advanced placement tests in (by gender), the types of bachelor's degrees earned by women (bachelor's and doctorates), and the types of STEM occupations that women have.

Studies covered in the article reveal three reoccurring themes of why there are fewer females in STEM: the common belief that men are mathematically superior or better suited than women for STEM fields; women tend to have a lack of interest in STEM, and issues with bias within the workplace. The article addresses the fact that research does not support that there is a "smarter sex", but "generally boys perform better on tasks using spatial orientation and visualization and on certain quantitative tasks that rely on those skills," while, "girls outperform boys on tests relying on verbal skills, especially writing, as well as some tests involving memory and perceptual speed" (p.20). Even though boys may usually outperform girls on spatial skills, females can improve their spatial skills easily with training, concluding that women have the capability to develop the same skills as men (Hill, Corbett, & St. Rose, 2010).

A journal article by Mosatche et al. (2013) covers some of the reasons that females tend to be less prevalent in the STEM fields, and effective programs that have been proven to encourage female students to pursue interest in those areas. The article presents evidence from over 400 studies "related to the possible causes of women's underrepresentation in STEM" (p.18) and identifies three reasons for this underrepresentation: "More boys than girls perform at the very highest levels in spatial reasoning and math ability, including on so-called 'gatekeeper' tests such as the SAT-M and GRE-Q. Girls who have high math abilities are more likely than boys who have high math abilities to also have high verbal abilities, giving them more choices of careers to

pursue. Women who have high math abilities are more likely than men with high math abilities to choose careers in non-math intensive areas. This preference shows up as early as adolescence" (p.18).

The article by Mostache et al. (2013) also poses many other possible reasons for the low number of women in STEM that have a common factor of lack of interest and confidence. As early as middle school, female students may underestimate their abilities, show less interest in math and science, and have a lower confidence level than their male counterparts. Academic sexism, which involves sexist comments regarding females abilities, has been shown to cause "lower perceived competence in [STEM] fields" and females who experienced sexist comments frequently "valued math and science less than those who experienced fewer such instances" (p.18).

Zeldin, Britner, and Pajares (2006) examined men in STEM careers and analyzed their 10 narrative stories. The purpose was to determine how the men's self-efficacy beliefs were established and how it related to their academic and career choice. The results of the study were then compared to another study conducted by Zeldin and Brinter in 2000 that examined the self-efficacy of women in STEM careers. The study found that the primary sources of self-efficacy differed for men and women. For men, their primary source was mastery experience, while women attributed social persuasions and vicarious experiences as their primary source. The study found their results to be consistent with Bandura's social cognitive theory, and that self-beliefs are a critical component to human motivation. Based on Bandura's tenants, Zeldin et al. also attributed the disproportionate participation of women in STEM fields as possibly being caused by the self-beliefs they

have regarding their capabilities to participate in a male-dominated field (Zeldin, Britner, & Pajares, 2006).

Encouraging Students to Join STEM

The article by Reis and Graham (2005) discussed many different ways for teachers to encourage students to participate in STEM, specifically science, technology, and math. The article stated how students' view of the importance of STEM activities or programs was affected by their learning styles, which differed depending on the gender of the student. In a specific instance where students were learning about using computers, male students tended to have more interest in how the computer programming worked, and female students showed more interest in knowing how to use to computers in a way that is applicable to life. This differentiation in viewpoints and learning styles between genders affects the methods that teachers should utilize in encouraging their students to become involved in STEM (Reis & Graham, 2005).

Reis and Graham (2005) compiled the findings of several different studies on how teachers can most effectively reach out to female students and encourage their participation and interest in STEM programs. Because males and females have different viewpoints and learning styles, certain measures have to be taken to encourage females' interest in STEM. From the information gathered from research and other studies, the article presented a variety of ways for teachers to encourage female student participation. Some of these included incorporating software and programs that appeal to female students, increasing their experience with technology, giving equal time to both male and female students to use high-tech computer activities, giving the female students the opportunity to discuss their ideas in a classroom setting, allowing for optimal learning

opportunities by placing females in small groups with other females, increasing their awareness of positive actions that can be taken through areas related to STEM, providing a nurturing, encouraging, and psychologically safe environment, offering support and boosting confidence, providing role models who maintain a lasting personal relationship, and showing examples of how other women have become successful in areas of STEM.

DeJarnette (2012) discusses in her article the need in America for students who are talented in STEM subjects. This brings to light the importance of early exposure to STEM, and covers information regarding current initiatives to encourage students towards STEM, the impact on elementary teacher education in STEM disciplines, and goals for future elementary STEM education. There are several programs regarding the initiative to encourage students to participate in these subjects, but few opportunities are available for elementary school students. The article covers research regarding students' early exposure to STEM and how those initiatives can affect students' perceptions and decisions. Current initiatives such as *The Partnership for 21st Century Skills* (2004), are working to "prepare American children to develop the skills they will need in order to compete in our global economy" and "help build the skill set needed for American students to succeed in STEM disciplines as well as global competition" (p.78). As a result of this initiative, educators have become more aware of the importance of early exposure to STEM for students in K-12. By incorporating a science, math, and technology based curriculum that involves interactive problem solving activities, it is the intention that elementary students will show an increase of interest in STEM fields (DeJarnette, 2012).

The article by McCrea (2011) covers different strategies for teachers to establish interest in STEM subjects for female students. According to McCrea (2011), females are

generally not as interested in STEM subjects as male students, but are more interested in projects that are humanitarian-type and relevant to social concepts. Which is the reasoning behind why females are "more likely to secure degrees in the humanities, the life sciences, and the social studies" (p.2). Teachers can apply this fact by incorporating ways for female students to use math and science to solve real-world problems. The article gives the example of the Clean Water Project as a way for female students to utilize knowledge about STEM subjects in projects that are beneficial to their communities. The article also suggest that stereotypes that portray STEM careers as more suitable for males, and nontechnical careers are more suitable for females, have an effect on women's mentality towards STEM. The crucial role of mentors in encouraging females' interest in STEM subjects is another topic discussed in the article. Females require "supportive and nurturing environments that include experienced female engineers and technical professionals" and "have to be able to identify with these mentors and see themselves filling similar roles" (p.3).

The literature available on the topic of teacher influence in students' decision to pursue STEM covers many aspects of the topic. However, most studies and articles focused on students from middle school aged to men and women with STEM careers. The available literature did not fully address the issue of how elementary school teachers were influencing their students. This study will focus on the influence of teachers in elementary schools and will give insight to how students are being encouraged or persuaded in their foundational years of learning. It will also examine if elementary school teachers take measures to encourage all students to become literate in STEM

subjects, if they depict subjects as gender-specific, or if they do not encourage STEM subjects at all.

Methods

Research Design

This mixed methods study consisted of a questionnaire to collect quantitative data, as well as an interview of selected teachers who participated in this study to collect qualitative data. It was designed so as to explore the perceptions of teachers on the importance of encouraging students to participate in STEM subjects, as well as what methods, if any, the teachers use within their classrooms to encourage students to participate in STEM subjects. The quantitative data was gathered from a group of elementary school teachers through a questionnaire regarding how important they consider encouraging students to participate in STEM subjects. After completion, the sources of data were analyzed to determine the overall perceptions of teachers regarding the importance of encouraging students to participate in STEM. The qualitative interview process was then used to explore in more detail what specific methods the teachers implemented to encourage students to participate in STEM.

Sample

The subjects of this study consisted of elementary school teachers (Grades 1-5) who are currently teaching at public elementary schools located in a rural school district in the Southeastern region of the United States. Approximately 65 teachers were asked if they would be willing to participate in the questionnaire and possible further interviews and observation of their classrooms. The participation size was a total of 45 teachers. Based on the answers given during the questionnaire, background, and years of

experience, three elementary school teachers were selected to participate in the interview process.

Data Collection

The initial survey was distributed to the elementary school teachers in person, either at the elementary school's faculty meeting, or by placing the surveys in the teachers' boxes at the front office and asking the teachers to return the surveys after completion. The survey was used to evaluate the teachers' opinions of encouraging student participation in STEM subjects. The survey consists of nineteen total questions. The first four multiple-choice questions asked the teachers to identify the school at which they taught, the grade and subjects they taught, and the number of years the teacher taught. The next fifteen questions were statements regarding the teachers' perceptions of incorporating STEM in the classroom, and asked the teachers to rate the statements on a five-point Likert Scale ranging from Strongly Agree, with a rating of five, to Strongly Disagree, with a rating of one. The response points were compiled to indicate the level of importance placed on encouraging student participation. The questions used were based on a study conducted by Riggs and Enochs (1989) examining the effect of teacher beliefs as a contributor to teacher behavior patterns while teaching science. The researcher acquired prior approval from the principals of the schools to distribute the surveys to the teachers for the purpose of the study. The data has and will remain confidential, and no school, student, teacher, or other personnel working at the school will be identified in the study. All of the survey questions and the format, as well as the interview questions can be viewed in the Appendix.

Results

Analysis

The data gathered from the survey was quantitatively analyzed to determine the overall perceptions of teachers in regards to encouraging students to participate in STEM, and to determine the percentage of teachers that place a high level of importance on encouraging student participation in STEM. The data from the survey was initially analyzed as a whole to evaluate the overall perceptions of teachers and find the percentage of teachers that placed a high level of importance on STEM subjects and encouraging students to participate in STEM. Because the teachers were asked to rate the statements in the survey on a five-point Likert Scale ranging from Strongly Agree, with a rating of five, to Strongly Disagree, with a rating of one, the response points were able to be compiled for each question to indicate the overall level of importance placed on encouraging student participation. The minimum, maximum, and mean scores for each question were compiled and are displayed in Table 1. A high score for each question (4 or above) indicates an agreement with the statement listed in the question and a high level of importance placed on STEM. After the data was compiled, it was then separated into two groups based on teachers who taught math and/or science in the elementary school and teachers who did not teach math or science, but taught other content areas (social studies, language arts, reading, etc.). Several of the teachers in the lower elementary grades (Kindergarten through 2nd grade) taught in all-inclusive classroom, meaning that they taught all subjects. These teachers were counted as math-science teachers. The data was separated to determine the differences in the opinions on the importance of STEM between the teachers who taught STEM subjects, and those who did not.

The quantitative data from the survey was also separated based on the types of questions asked. The first seven questions, as well as questions fourteen and fifteen, involved statements related to the teacher's attitude toward STEM. These questions included statements the teachers were asked to rate regarding topics such as the importance of the students' interest in STEM subjects, whether or not the teacher should encourage students to participate in STEM subjects, if the teacher put forth effort to make STEM subjects fun and engaging to the students, etc. Questions eight through thirteen involved questions related to the teacher's efficacy and their level of confidence in their ability to teach STEM subjects. These questions included statements the teachers were asked to rate regarding topics such as their ability to teach STEM content effectively, their ability to assist students who have difficulty or struggle in understanding STEM subjects, and whether the teacher felt they could make STEM subjects fun and engaging for the students. An independent t-test was completed to compare the attitude toward STEM and the efficacy to teach STEM of teachers who taught math and/or science in the elementary school and teachers who taught other content areas. The collected information is displayed below in Table 2.

As shown in Table 1, the mean scores for each of the questions were all higher than a 4, which is relatively high on the scale from 1 to 5. The question with the highest mean score was Q3 with a mean score of 4.84. Q3 asked teachers to rate the statement "It is important for teachers to make mathematics fun and engaging for students." The question with the second highest mean score was Q1, which asked the teachers to rate the statement "It is important for students to be interested in science and mathematics." Both

Q1 and Q3 had a minimum score of 4, which shows that all of the teachers surveyed in this study stated that they agreed or strongly agreed with the statements in Q1 and Q3.

The higher average score indicated a stronger agreement with the statement given in the question. Because the mean score for each question in the survey was above a 4, this indicated that, overall, the teachers agreed with the statements given for each question. This also indicated that the teachers generally considered student interest in STEM and encouraging students to participate in STEM to be of high importance.

The lowest mean score of all of the questions was a 4.2 on Q8. This question asked teachers to rate the statement "I understand how to effectively use technology and am confident in my ability to use it in the classroom." The minimum score given on this question was a 1, indicating that certain teachers who participated in the survey strongly disagreed that they were able to effectively use technology in the classroom.

Overall, the questions related to the teachers' attitude toward STEM (Q1-7, Q14-15) had higher mean scores than the questions pertaining to the teachers' efficacy on teaching STEM (Q8-13). The attitude questions also had greater minimum scores (lowest minimum score was a 3) than the efficacy questions (lowest minimum score was a 1). The overall greater scores for the attitude questions demonstrated that the teachers strongly agreed on the importance of student interest and engagement in STEM, but were not as confident in their abilities to effectively teach those subjects and make them engaging for the students.

The data was divided into two groups; teachers who taught math and/or science and teachers who taught other content areas. The attitudes and efficacy of the two groups were analyzed separately to determine if there was a difference in the two groups of

teachers, and if teaching the STEM subjects caused the teachers to have a higher score on the questions relating to attitude and/or efficacy. After analyzing the data separately, I found that overall both the math-science teachers and the other content teachers had a higher score for attitude than efficacy, showing that even the teachers who taught the STEM subjects did not as strongly agree that they were able to effectively teach the content.

As shown in Table 2, I found that the attitude for the math-science teachers was higher than that of the other content teachers, supporting that the math-science teachers placed a greater importance on student involvement and encouragement in STEM than did the other teachers. I also found that the math-science teachers had a greater level of efficacy in effectively teaching the STEM subjects than the other content teachers, and that there was a significant correlation between the teacher efficacy and the subjects they taught.

The lower score on teacher attitude for the other content teachers may be caused by the fact that these teachers do not teach math or science, and they may consider the subjects they do teach to be of greater importance, such as reading or social studies. Additionally, because the math-science teachers teach STEM subjects on a daily basis and are more familiar with how to teach math and science content, that may be a factor in the greater levels of efficacy in the math-science teachers.

Table 1

Descriptive Statistics on Survey Items

Question	N	M	SD	Min	Max
Q1	45	4.8	.40	4	5
Q2	45	4.7	.50	3	5
Q3	45	4.8	.37	4	5
Q4	45	4.7	.54	3	5
Q5	45	4.6	.55	3	5
Q6	45	4.7	.51	3	5
Q7	45	4.4	.69	3	5
Q8	45	4.2	.88	1	5
Q9	45	4.4	.86	2	5
Q10	45	4.3	.72	2	5
Q11	45	4.3	.66	3	5
Q12	45	4.3	.85	2	5
Q13	45	4.3	.79	1.5	5
Q14	45	4.8	.43	4	5
Q15	45	4.8	.40	4	5

Table 2

T-test Results for Math-Science teachers and other content area teachers

Outcome	Group						95% CI for Mean Difference		
	Math-Science			Other content areas					
	M	SD	n	M	SD	n		T	df
Attitude	4.73	.30	33	4.54	.44	9	-.06, .45	1.52	40
Efficacy	4.44	.48	33	3.81	.63	9	.24, 1.02	3.26*	40

*p <0.05

Qualitative

The qualitative data portion of this study was collected to further clarify the answers provided during the survey, and also to answer the second research question that guided this study; "What methods, if any, do elementary school teachers use within their classrooms to encourage students to participate in STEM?" To collect the qualitative data portion of this study, three elementary school teachers who participated in the survey and taught mathematics and science were selected for an interview based on meeting the criteria presented through the survey as well as volunteering to participate in the interview. The participants who were chosen had various backgrounds and years of experience to better represent the variation among the elementary school teachers who participated in the survey. Even though the participants in this study had varying years of experience in the classroom, each of the participants chosen had been teaching in the elementary school for at least five years to ensure that they had developed their opinions, methods, and suggestions based on several years of experience in the classroom.

The interviews were transcribed and then the data from the interviews were collected, analyzed, and compared from person to person to determine patterns within the answers provided during the interviews. The patterns that were found throughout the interviews represented a relationship of ideas among the interviewees and were coded in order to determine common themes. The themes represent how the data was reduced and the patterns that were present in the interviews. There were ten common themes found that were taken from the codes for the purpose of the analysis. Seven of the common themes answer what methods the teachers use to engage the students in mathematics and science (in and out of the classroom), while the other three themes are related to what the

teachers believe could increase their efficacy in teaching mathematics and science effectively. These themes are listed and described below along with the responses of the interviewees.

Group Learning/Scaffolding

All three of the interviewees that participated in this study discussed how they incorporated the use of small group during instruction, or the use of scaffolding as an instructional strategy as a way to engage the students in mathematics and science within the classroom. Using small groups during class time permitted the teachers to differentiate instruction based on the students' learning needs, while also letting the teachers to work with a smaller number of students at a time; allowing the teacher to concentrate her attention. One of the participants stated that she will usually "have a group that works on the computers, a group that works on activities independently, and a group that I work with on concepts that are more difficult for them". This participant discussed how she would rotate each of these groups so that each group had an opportunity to work at each station, and she could more effectively address the needs of the students.

Each of the three teachers that participated in this study spoke of how they incorporated scaffolding, or peer-tutoring as an instructional method to encourage student participation in STEM. The teachers would use "peer helpers" which are "students that have mastered a concept or area of content, and can help the students who are having more difficulty". The participants discussed how using peer-tutor or "peer-helpers" would help encourage the students because often times, the students who had mastered the content could more effectively connect with their peer who was having difficulty than

the teacher could. The students who were struggling were also usually very receptive of the assistance from peers, and were encouraged to participate when they saw that their peers were interested in the content. Another way that the participants of the study used peer involvement to encourage their students to participate was to encourage a class discussion. By posing a question to the students, and allowing the students to discuss their ideas and answers with each other before being provided with the correct answer, the students were able to "popcorn' off of each other's ideas and share personal knowledge that helps them reach a final answer". One of the teachers that participated in this study used the class discussion as a way for the students to learn from each other, and also as a way to create curiosity and interest about the content they were discussing.

Real-World Application – Lack of Understanding by Students of Real-World Application

Another theme that was frequently discussed during the interviews was that of real-world application, or making the content applicable and relatable to the students. This was an instructional strategy used by all three of the participants to engage the students in the mathematics and sciences content they were teaching. By incorporating the real-world application of the content, the teachers were making the content something the students could better relate to and understand. Each of the teachers that were interviewed agreed that mathematics and science were foundational to our lives, and that it was important for the students to recognize the use of math and science in their everyday lives. The teachers spoke of how showing the students the real-world connection of these subjects helped the students understand their importance, and increased the students' engagement while learning the subjects. One of the participants included that "Most careers use math and science even if it is in a small way, and I think

it is important for students to recognize the importance of these subjects and how knowing how the things they are learning in the classroom can be beneficial in the real world."

Although the teachers agreed that incorporating the real-world application of the subjects was important while teaching, each of the teachers also spoke of how, prior to learning the connection, many of the students did not understand how the things they were learning about in the classroom connected to the outside world. The participants mentioned how students did not realize the application for mathematic operations such as fractions in activities such as cooking or measuring materials. To assist her students in making a connection to the application of mathematics and science in the real world, one of the participants had her students participate in an activity where she provided them with a list of job titles and asked the students to choose which ones they thought used STEM subjects. All of the job titles on the list utilized STEM in some way. However, most of the students do not recognize this prior to completing this activity. This activity is used to show the students the value and importance of math and science, and present the career opportunities available related to STEM subjects.

Hands-On Activities – Enrichment Activities

Integrating activities that enabled the students to have a hands-on learning experience while learning about math and science content, was a common theme among all three of the participants interviewed for this study. In addition to that, the participants also integrated activities that enriched the students' learning experience. Although the activities the teachers used varied due to the needs of their classrooms and the age group they taught, all three of the teachers spoke of using various hands-on and enriching

activities to engage the students in learning about STEM subjects. One of the participants stated that through her years of teaching, she has found a "see, touch, do" method to be the most effective way to teach science. The other participants discussed how they incorporated science experiments such as making erupting volcanoes, building circuits, finding magnetic objects, and even drawing observations of moon phases to engage the students in science lesson. When teaching math content, two of the teachers mentioned using math manipulatives to teach concepts such as fractions, regrouping, and multiplication/division. Integrating these hands-on activities to engage the students in learning is not a practice used in isolation by the teachers interviewed for this study. Using the hands-on activities during instruction is a practice that is supported by a learning theory recognized in the Early Education community. The Constructivist Learning Theory argues that the students create knowledge and meaning based on their experiences. Students create this knowledge by being active in the learning process, rather than simply being receivers of lectured information. The theory supports that students should participate in hands-on activities, such as the ones mentioned by the participants of this study, when learning new content.

To enrich the students' learning experience, the teachers interviewed discussed how they included additional challenging problems during math, and planned as many field trips as possible. While teaching mathematics, one teacher included "challenge problems" to address the needs of the higher level students in her class. Depending on the content being taught, these problems may include additional required steps to solve the problem, larger numbers, or longer word problems. These problems were considered optional, but were included to ensure that the material was still challenging to the

students who may have mastered the basic concepts. Planning field trips was mentioned by two of the teachers interviewed as a way to engage the students and enrich their learning experience. These teachers planned field trips to science museums to give the students the opportunity to view exhibits related to content they were learning about in class, and provide an enriching experience that went beyond the routine school day.

Encouraging the Independent use of Technology at School and at Home

Technology is becoming increasingly available in the elementary school classrooms as well as in the students' homes. The classrooms of the teachers interviewed during this study included a variety of technological resources including interactive whiteboards, multiple desktop computers, Chrome books, and iPads. The teachers that participated in this study discussed how they utilized these various resources to teach the students how to use the technological resources while also teaching the subject content during whole class instruction, small group instruction, and individual work. Two of the teachers discussed how they would model solving math problems using the interactive whiteboard, and then allow individual students to use the interactive whiteboard to solve problems themselves. The teachers would ask the students to "talk through" each step they were taking to solve the problem, and justify why they solved the problem that way. The participants also mentioned how they encouraged students to use technology at home or outside of school whenever possible. When asked about encouraging her students to participate in STEM activities outside of the classroom, one of the participants stated, "I do encourage my students to use technology…we have so many programs that they can access at home for math that I recommend". The other participants also mentioned encouraging students to use whatever technological resources they have available at

home to assist them in learning the content, as well as encouraging students to try certain science activities and experiments at home and visiting museums of science and aviation outside of class field trips.

Make Learning Fun

One theme that was common among all of the participants, and was interwoven into the various strategies they used to engage the students in STEM subjects, was the idea of making learning fun or enjoyable for the students. Each of the participants spoke of how they integrated various games, activities, experiments, and instructional strategies to make learning STEM subjects enjoyable for the students. The participants spoke of how the students loved the experiments and demonstrations they did during science lessons. One participant stated that "The science content I teach really allows me to pull in a lot of experiments and demonstrations that the students love. We get to do things like play with magnets, build circuits, and make volcanoes -- I think that is their favorite part". The teachers also talked about how the students enjoyed other instructional strategies that were used in the classroom, such as teaching in small groups, incorporating games, having students work with partners, and using hands-on activities. Another participant stated that "the more I can use hands-on experiments demonstrating the subject matter, the better. I have had many students tell me that they love the experiments and demonstrations we do in class. Those topics are usually the ones they do the best on when it is time to test on the content." The participants in this study employed various strategies to make learning the content fun and enjoyable as a strategy to engage the students in learning the content, and also to assist in making the content memorable to the students.

Increasing Teacher Efficacy in Teaching STEM Subjects

In addition to discussing the methods they used to engage their students in STEM subjects, the participants in this study also gave insight to methods they believed would help to increase their ability to teach STEM subjects effectively. From this discussion, three themes arose; increasing the availability of materials, participation in professional development, and reducing the student/teacher ratio in the classroom. When conversing about what would be the greatest resource in improving her ability to effectively teach STEM subjects, one teacher noted that she believed "the biggest thing that would help me better teach these subjects would be more materials and more help…with more available materials, I think I could make the lessons more engaging and effective for the students". Participating in classes related to professional development or learning more about how to use available programs and resources was brought up by each of the participants as a way to increase their efficacy. Using professional time allotted to the teachers to learn about available math and science programs, providing training for how to incorporate hands-on/active learning activities, and information sessions about what resources are available to teachers were all suggestions provided by the participants. One participant included that she "would love to learn more ways for students to be active learners." She also added "There are always more things to learn about engaging students, and I think training sessions would be a great way for teachers to learn about how to incorporate those things in their classrooms." The third method to increase efficacy of reducing the student/teacher ratio was suggested by two of the teacher participants during the interviews. They spoke of how one teacher in the classroom "can only do so much", and how having more assistance or more teachers in the classroom would enable the

participants to incorporate more small group instruction. According to one of the participants, "I feel like my instruction is so much more effective when I am working with 4-8 students, rather than when I am working with a whole group." By utilizing more small group instruction, the participants could concentrate their attention on a few students and more effectively meet the needs of the students while teaching them science and mathematics content.

Discussion

Through the survey given to the elementary school teachers, I sought to answer my first research question: "What are the perceptions of elementary school teachers on engaging students' interest and participation in STEM?" Based on the results from the survey, I found that, overall, the teachers who were surveyed showed a positive attitude towards STEM and perceived students' engagement and interest in STEM to be important. All of the teachers who participated in the survey stated that they "agreed" or "strongly agreed" that it is important for students to be interested in science and mathematics (Q1). All of the teachers also agreed or strongly agreed that it is important for teachers to make science and mathematics fun and engaging for students (Q3).

The second research question, "What methods, if any, do elementary school teachers use within their classrooms to encourage students to participate in STEM?" was answered through the interview portion of this study. The interviews conducted during this study sought to gain a more in-depth understanding of the elementary school teachers' perceptions, and discover what methods the teachers who participated in the interviews were using within their classrooms to encourage student participation in STEM. Through the interviews I found that all of the teachers agreed that it was

important for students to be interested in science and mathematics. The teachers who were interviewed all discussed that encouraging students to participate in STEM subjects was important because of the application of the content in the classroom as well as in the real world. They agreed that math and science were foundational subjects and applied to various aspects of life in countless ways. Each of the teachers also discussed how they all used a variety of methods in their classrooms to engage students in STEM subjects, and even encouraged the students to participate in STEM subjects outside of school.

The strong agreement from the teachers on the importance of engaging students' interest in STEM may be due in part to the current push for STEM awareness by the Obama administration and other nationally recognized foundations such as the American Association for the Advancement for Science and the National Science foundation. In 2009, President Obama launched the "Educate to Innovate" campaign in efforts to help move American students towards greater achievement in math and science. In addition to that, current initiatives, such as the *Partnership for 21st Century Skills*, seek to prepare American children to develop the skills they will need in order to compete in today's global economy, namely skills related to STEM (DeJarnette, 2012). As a result of these pushes for students to achieve in STEM, educators have become more aware of the importance of early exposure to STEM for students in elementary school, and thus showed a strong agreement with the importance of STEM in the survey as well as the interviews.

Along with question 1 and 3, teachers also showed a strong agreement with questions 14 and 15 in the survey. These questions asked the teachers about their opinion concerning whether or not they consider teachers to be an influence in students' interest

in subjects and if teachers can affect students' opinion and attitude towards subjects. In this study, the teachers surveyed all agreed that teachers are a big influence on a student's interest in a subject and that teachers can affect a student's opinion of and attitude towards a subject. These results support the findings of the studies conducted by Hill et al. (2010), Mosatche et al. (2013), and Zeldin and Pajares (2000), in which they found teacher influence could be a determining factor in students' decision to pursue STEM fields. The data I collected also parallels the results of the study conducted by Hall et al. (2011), which detailed teachers influence on students career choice was second only to students' overall interest in the content.

The fact that teachers recognize themselves as influential to the students' interest in a subject and understand that they can affect a student's opinion and attitude toward a subject is important in order for teachers to be aware of their impact on a student's interest in STEM. When teachers are aware of the impact they have on students' interest in STEM subjects, they can be more cautious of how they portray those subjects; insuring that they portray them in a positive manner, and can be intentional about using their influence of students' opinion and attitude to encourage students to be interested and participate in STEM subjects.

The results of this study also showed that although teachers had positive attitudes towards STEM, and strongly agreed with its importance, both the math-science teachers and the other content teachers had a lower score on the efficacy portion of the survey. Question 8 had a minimum score of 1, indicating that certain teachers strongly disagreed that they were able to effectively use technology in the classroom and were not confident in their ability to use technology in the classroom. Certain teachers also disagreed that

they knew how to teach math and science effectively and that they knew how to make math and science engaging for students. A study conducted by Ross (1998) that focused on the consequences of teacher efficacy showed that teachers with low self-efficacy to engage in inquiry based projects tend to refrain from using such a curriculum with their elementary students. As a result, these teachers tend to have lower student achievement in their classroom. When teachers have positive self-efficacy towards instructional methods, however, they are more likely to engage students using that method. Although the United States demands that teachers be highly qualified, many teachers lack confidence to teach scientific inquiry in the elementary school classroom, according to Bencze (2010).

The elementary school teachers surveyed in this study agree on the importance of encouraging students to participate in STEM but may lack the knowledge of effective strategies for teaching the content. As the results of the survey showed, the teachers who taught other content areas besides math and science had a lower score for efficacy than the math-science teachers. This may be partially due to the fact that the other content teachers do not teach math-science on a daily basis and may not be as confident in their ability to teach content they do not usually teach. However, it is important for all teachers to be confident in their abilities to effectively use and incorporate technology in the classroom. STEM concepts can be incorporated across the curriculum, even in subjects such as reading, writing, and social studies. Therefore, it is important for even the other content teachers to be able to effectively incorporate STEM concepts. In order to teach STEM subjects successfully, elementary school teachers need support in knowing how to effectively teach the content and assistance in learning ways to make the content fun and engaging.

To address the lower efficacy score of the teachers during the survey and find out how to assist the teachers in increasing their efficacy, the participating teachers were asked to discuss programs or opportunities that would help them feel more capable of teaching STEM subjects effectively during the interview portion of this study. Their responses showed suggestions that they, as experienced teachers, believed would be beneficial in improving the efficacy of elementary school teachers in teaching STEM subjects. The teachers pointed out three main ways they believe could increase efficacy among teachers. They mentioned that an increase in available materials related to teaching STEM, participation in professional development classes or meetings, and a reduced student/teacher ratio in the classroom would assist in making them feel more efficacious in teaching and engaging students in STEM subjects.

Conclusion

Teachers are an influential factor in students' career choice, and students consider teacher encouragement to be very important to their decision, as revealed by the study conducted by Hall et al. (2011). For this reason, it is vital to ensure that teachers are actively encouraging student participation in science, technology, engineering, and mathematics, and know how to effectively teach those subjects. It is especially important to consider how students are being influenced regarding STEM during their foundational years of learning in elementary school. I conducted this research to give insight to what the perceptions of elementary teachers are regarding the importance of encouraging their students' interest and participation in STEM, and find out what methods the elementary school teachers were using to engage their students in STEM.

The literature available relevant to the topic of teacher influence in students' decision to pursue STEM covers many aspects of the topic. However, most studies and articles focused on students from middle school age to men and women with STEM careers or on teacher efficacy as it pertained to all subjects. Because the available literature did not fully address the issue of how elementary school teachers were influencing their students, I wanted to focus this study on the influence of teachers in elementary schools and give insight to how students are being encouraged or persuaded in their foundational years of learning.

After analyzing the results of this research, I found that, overall, the teachers who participated in the study strongly agreed that it was important for students to be interested in STEM subjects and for teachers to encourage students' interest in STEM subjects, but teachers did not as strongly agree in their abilities to effectively teach STEM content or make it fun and engaging for the students. During the interview portion of this study, I was able to elicit suggestions from the participating teachers on ways they believed to be beneficial in increasing their efficacy. Each of the participants have been teaching in an elementary school for at least five years, and provided insights and suggestions that are formed from years of experience within the classroom. All of the participants offered valid methods and suggestions that should be taken under consideration when determining how to increase the efficacy of teachers in teaching STEM subjects.

Because teachers are such an influential factor in students' decisions, it is imperative that teachers not only regard encouraging students to participate in STEM as highly important, but it is also equally important that teachers be equipped to effectively teach the content to their students and be able to make these subjects engaging to the students.

To ensure elementary school teachers are equipped to effectively teach and engage students in STEM, it would be beneficial for school administration to take measures to implement the suggestions of the teachers who participated in this study and provide teachers with needed materials, professional development, and additional assistance in the classrooms whenever possible. These measures could increase the efficacy of teachers in teaching STEM subjects as well as increase the engagement and participation of students in STEM subjects.

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Appendix A

Teacher Influence on Student Interest in STEM Survey

Thank you for taking time to complete this survey concerning teacher influence on student interest in science, technology, and mathematics (STEM) activities. Your feedback is important to GSU and Bulloch County Schools. This survey should only take about 5 minutes of your time. Your answers will be completely anonymous. If you are interested in a follow up interview or have any questions about this survey, please contact me at ch05706@georgiasouthern.edu

Demographics

At which school are you currently teaching?

- Sally Zetterower
- Julia P. Bryant
- Nevils Elementary
- Brooklet Elementary
- Mattie Lively

What grade do you teach?

- Kindergarten
- 1st
- 2nd
- 3rd
- 4th
- 5th

What subjects do you teach? (Select all that apply)

- Reading
- Language Arts
- Mathematics
- Science
- Social Studies
- Foreign Language
- Physical Education
- Computer Science

How long have you taught at the elementary level?

- 1-3 years
- 3-5 years
- 6-8 years
- 8-10 years
- 10 years or more

Influences on STEM

Please indicate the degree to which you agree or disagree with each statement below by filling in the appropriate bracket beneath each statement.

Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
1	2	3	4	5

1. It is important for students to be interested in science and mathematics.
   [1] [2] [3] [4] [5]

2. It is important for students to be familiar with technology and use it in the classroom.
   [1] [2] [3] [4] [5]

3. It is important for teachers to make science and mathematics fun and engaging for students.
   [1] [2] [3] [4] [5]

4. Teachers should continually look for more effective ways to teach science and mathematics.
   [1] [2] [3] [4] [5]

5. Teachers should try to incorporate technology into the daily classroom activities.
   [1] [2] [3] [4] [5]

6. Teachers should encourage students to be interested in science and mathematics.
   [1] [2] [3] [4] [5]

7. Teachers should encourage students to participate in science, mathematics, and technology-related activities outside of the classroom.
   [1] [2] [3] [4] [5]

8. I understand how to effectively use technology and am confident in my ability to use it in the classroom.
   [1] [2] [3] [4] [5]

9. I understand science and mathematics concepts well enough to be effective in teaching my level of science and mathematics.
   [1] [2] [3] [4] [5]

10. I know the steps necessary to teach science and mathematics concepts effectively.
    [1] [2] [3] [4] [5]

11. When a student has difficulty understanding a science or mathematics concept, I am capable of helping the student understand the concepts better.
    [1] [2] [3] [4] [5]

12. I spend extra effort trying to make science and mathematics interesting to students.
[1] [2] [3] [4] [5]

13. I know how to make science and mathematics fun and engaging to students.
[1] [2] [3] [4] [5]

14. Teachers are a big influence on a student's interest in a subject.
[1] [2] [3] [4] [5]

15. Teachers can affect a student's opinion of and attitude towards a subject.
[1] [2] [3] [4] [5]

Appendix B

Teacher Interview Questions

1. What methods do you use in your classroom to engage students in mathematics?

2. What methods do you use to engage your students in science?

3. Why do you think it is important for students to be interested in math and science?

4. What programs or opportunities would help you feel more capable of teaching these subjects effectively?

5. Do you encourage your students to participate in science, math, engineering or technology related activities outside of the classroom? If so, what activities?