K-5 STEM Grants

Evaluation and Outcomes Report

OSIT Nevada Governor's Office of Science, Innovation and Technology

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According to the research, one-third of boys and girls **lose an interest** in science by the fourth grade*

A child's interest in STEM is **largely formed** by the time he or she reaches upper elementary and middle school.*

Early exposure to STEM, **especially for girls**, makes children more likely to succeed in science and pursue STEM fields in college.*

Yet…

… just **38%** of Nevada's elementary schools report offering STEM during the school day.**

Therefore…

… if the State's goal is to increase the number of students participating in STEM programs in middle and high schools that prepare them for success in post-secondary STEM degrees, research suggests STEM concepts should first be introduced **at the elementary level**.***

*Daugherty, Michael K.; Carter, Vinson; and Swagerty, Lindsey (2016) "Elementary STEM Education: The Future for Technology and Engineering Education?," Journal of STEM Teacher Education: Vol. 49 : Iss. 1 , Article 7.

**According to a statewide survey of STEM practices conducted in May, 2016 by the NV STEM Advisory Council.

***DeJarnette, N. K. (2012). America's children: Providing early exposure to STEM (science, technology, engineering and math) initiatives. *Education*, 133(1), 77–84.

K-5 STEM Grants

Program Goals

K-5 STEM Grants seek to increase access to high-quality STEM programs in elementary schools in order to:

- ❑ **cultivate and maintain an interest in STEM in younger grades, and**
- ❑ **Lay the foundation for the skills needed for a career pathway to success in the New Nevada.**

This grant program aligns with four key strategies identified in the Nevada State STEM Strategic Plan:

- ❑ To increase the prevalence of evidence-based, high-quality formal and informal STEM practices and programs in Nevada's elementary schools.
- ❑ To increase the use of hands-on, evidence-based, experiential STEM learning in grades K-5.
- ❑ To increase the percentage of elementary schools that teach science for three-plus hours per week.
- ❑ To increase interest in, awareness of, and achievement in the subjects of science, technology, engineering, and mathematics in grades K-5, particularly amongst demographic groups that are traditionally underrepresented in STEM.

K-5 STEM Grants

2 Grant Opportunities

K-5 STEM Classroom Grant

- ❑ Targeted at individual classrooms
- ❑ Funds innovative, creative approaches to teaching STEM concepts
- ❑ Funded with private dollars
- ❑ 12 Classroom Grants were awarded

K-5 STEM Program Grant

- ❑ Targeted at the grade-level or school-level
- ❑ Funds purchase of high quality, vetted programs on the STEM Advisory Council's List of Recommended STEM Programs
- ❑ Funded with private dollars
- ❑ 6 Program Grants were awarded

Awarded Schools

K-5 STEM Classroom Grant

- ❑ Bordewich Bray Elementary School- Carson City
- ❑ Mark Twain Elementary School- Carson City
- ❑ Bordewich Bray Elementary School- Carson City
- ❑ Oasis Academy- Fallon
- ❑ Fernley Elementary School- Fernley
- ❑ Riverview Elementary School- Dayton
- ❑ Spanish Springs Elementary School- Reno
- ❑ Sepulveda Elementary School- Reno
- ❑ Peavine Elementary School- Reno
- ❑ Peavine Elementary School- Reno
- ❑ Gomes Elementary School- Reno
- ❑ Mt. Rose Elementary School- Reno

K-5 STEM Program Grant

- ❑ Douglas County Elementary Schools
- ❑ Carson City Elementary Schools
- ❑ Oasis Academy- Fallon
- ❑ Yerington Elementary Schools- Yerington
- ❑ Hugh Gallagher Elementary School- Virginia City
- ❑ Coral Academy of Science- Reno

K-5 STEM Grants

Summary of Grant Outcomes and Evaluation

Total Student Impact: 5,136 students attending 24 elementary schools will benefit annually from greater access to STEM curriculum and materials.

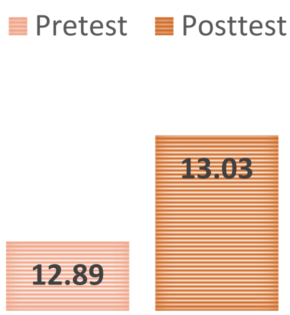
2,046 students will benefit each year from new and innovative STEM equipment and lessons plans.

3,090 students each year will have access to high-quality STEM curriculum from programs that increase interest in STEM careers and academic achievement.

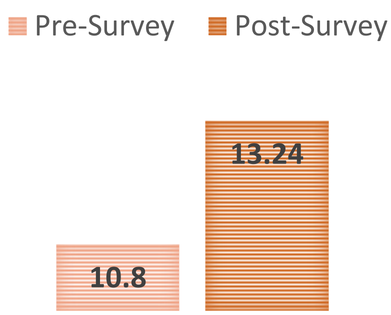
82 teachers are benefiting from high-quality STEM teaching materials and equipment.

Total Funding: $134,129*

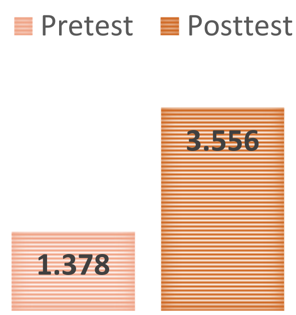
STUDENT INTEREST IN STEM (K-2)



STUDENT INTEREST IN STEM (3-5)



STUDENT CONTENT KNOWLEDGE



*External program evaluation conducted by the Raggio Research Center at the University of Nevada Reno: $15,871

Full K-5 STEM Evaluation Report

K-5 STEM Grant Evaluation Report

Final Report

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12.31.18

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K-5 STEM Evaluation Report

The K-5 STEM Grant from the Governor's Office of Science, Innovation, and Technology (OSIT) was a grant program, funded by the Pennington Foundation to assist in getting STEM programs and curriculum into classrooms across Nevada.

Introduction

Drs. Catherine Pozarski-Connolly and Camille T. Stegman were Co-Investigators and Dr. David Crowther supervised the evaluation of the K-5 STEM Education Program Grant (K-5 STEM). K-5 STEM was announced in November 2017. "The purpose of the program was to increase the prevalence of evidence-based, high-quality formal and informal STEM practices and programs within Nevada's elementary schools." (OSIT, 2017) The funding came in two forms; 1) a classroom award for up to $1,500 and 2) a program award for up to $20,000.

K-5 STEM had four over-arching goals that guide its purpose. The goals focused on supporting equitable access to quality of STEM programs in elementary schools to prepare students for STEM careers in the New Nevada. More specifically, the goals were:

> Goal 1: To increase the prevalence of evidence-based, high-quality formal and informal STEM practices and programs in Nevada's elementary schools.
>
> Goal 2: To increase the use of hands-on, evidence-based, experiential STEM learning in Grades K-5.
>
> Goal 3: To increase the percentage of elementary schools that teach science three-plus hours per week.
>
> Goal 4: To increase interest in, awareness of, and achievement in the subjects of science, technology, engineering, and mathematics in grades K-5, particularly amongst demographic groups that are traditionally underrepresented in STEM. (OSIT, 2017)

Exhibit 1 provides an overview of the program and classroom awardees requirements to receive K-5 STEM funds.

Exhibit 1: K-5 STEM Requirements

Program Awardees	Classroom Awardees
o Pre-and post-STEBI-A o Pre-and post-STEM Interest Student Survey o Pre-and post-classroom Assessments from the Program or teacher developed	o Pre-and post-STEBI-A o Pre-and post-STEM Interest Student Survey
Carson, Douglas, Storey, Lyon, and Churchill County district schools received funding	Carson, Washoe, Churchill, and Lyon County teachers received funding
Programs purchased include: STEM in Action, Project Lead the Way, Desert Research Institute (DRI) Green Boxes – STEM Snacks, Kinderlab Robotics	Classroom materials purchased include: Sierra Nevada Journeys Curriculum, DRI Snow Collection Kits, Full Option Science Systems (FOSS), ROK Blocks, Robotics and Coding, STEM Supplies, Hydro Geology Stream Table, DRI Green Boxes

Summary of Results

K-5 STEM provided funding to districts, schools, and classroom teachers. The evaluation found increases in student interest in STEM subjects in both K-2 and 3-5, student awareness of engineering as a useful skill at the 3-5 level, and student content knowledge. The evaluation did not find evidence that teacher self-efficacy increased or that every barrier to STEM implementation was removed; however, teachers expressed that there were changes to their classroom culture, including amounts of time spent teaching STEM, student engagement, student collaboration and discussion, problem solving skills, and overall excitement about engaging in STEM. The following sections provide more information about each of these results.

Data Collection and Statistical Analyses

Program implementation was less than a school year. In several cases, program materials were not received until late spring of 2018 allowing for only six to eight weeks of program use. Some implementations took place during the first two months of the 2018 school year. This may have been a contributing factor to the lack of change in teacher self-efficacy. Changes to self-efficacy require time, professional development, and high-quality materials (Darling-Hammond, 1995; Garet, Porter, Desimone, Birman, & Yoon, 2001; Reiser, 2013; Wilson, 2013).

Both statistical and teacher perceptions were used to conduct this evaluation. Two surveys utilizing Likert-style data were created for the grant, one for Grades K-2 students and one for Grades 3-5 students (Appendix A). Due to the nature of Likert data, an independent samples Mann-Whitney U was applied to the data to determine if student attitudes changed. A second analysis, chi-square, was applied to items requiring the student to select more than one option and to items that could not be coded with a value, such as categories. The results of the analysis are represented as a *p*-value, or probability value. Education tends to use a *p*-value of 0.05 or less to show that the differences in the data sets were not the result of error, but rather the result of some intervention. Additionally, the effect size that resulted from an analysis aids in determining how large the difference was, or how big of an impact the intervention made in respect to the scores received.

Teacher perceptions were gathered during informal interviews. Each of the five schools that received program funding were required to participate in pre- and post- focus group sessions. Each session lasted from 30-75 minutes and included nearly all participants that received program supplies and/or training. On a couple of occasions an educator was absent from a pre- or post- focus group session, but overall the rate of participation in the pre- and post- focus groups was above 97%. All interviews were transcribed and coded leading to several themes that were consistent across all the participants.

Student Interest in STEM

A STEM interest survey was created by the Raggio Research Center for the purpose of this evaluation. Two levels of the survey were created, one for kindergarten through second grade students and one for third through fifth grade students. The purpose of the survey was to determine if student interest in school or in STEM subjects changed after classroom instruction occurred utilizing the materials or kits purchased through grant funds. Teachers who received funds or were part of the program level funding were asked to administer the interest survey to all students in their classrooms before any instruction utilizing purchased STEM materials and after instruction using the STEM materials. The survey for each grade band was available on SurveyMonkey.com and as a paper copy. Teachers could administer the survey in either format, and teachers in the kindergarten through second grade could read the survey to their students. Student responses were numerically coded and entered into a spreadsheet for statistical analysis. A copy of the student STEM interest surveys can be found at the end of this report (Appendix A).

Kindergarten through Second Grade Survey

The kindergarten through second grade survey included six selected response questions utilizing a Likert format for five questions and one single response item. The items used pictures and simple verbiage to account for the age and developmental level of the students. Two analyses were applied to the data. Questions 1-5 were scored on a 3-point Likert scale with a total possible score of 15, indicating a student feeling the happiest about STEM-related activities in class, and the lowest score of 5, representing a student who feels unhappy about doing STEM-related activities in class. Students who colored in more than one answer or who did not complete the question were eliminated from the analysis. STEM survey data were collected and analyzed for 576 students in the pretest and for 522 students in the posttest. Results of the assessment indicated an increased attitude towards STEM subjects from pretest to posttest with a small effect size (mean pretest = 12.89; mean posttest =

13.03; $p = 0.032$; $r = 0.073$). A post hoc evaluation determined the power of this assessment to predict changes was greater than 99%, meaning the results of the Mann Whitney U were reliable. These results of the analysis suggest that student attitudes towards STEM subjects and activities in school can be influenced by teacher actions. Students seemed to enjoy school more as one teacher reported, "It's great for the kids. It's not like your goal [for] reading, math. They love it and if we can expose them more, they're actually learning when they think they're not, and it's fun." Since the surveys were given before and after instruction using the STEM materials or kits purchased utilizing funds from the grant, it could be noted that providing materials teachers need to teach STEM subjects in research-based, inquiry formats can increase a student's attitudes, interest, and enjoyment towards these disciplines.

Table 1: K-2 Attitudes Comparison

	N		*Mean*		*SD*		*W*	*p*	*r*
	Pre-	**Post-**	**Pre-**	**Post-**	**Pre-**	**Post-**			
K-2 Attitudes	576	522	12.89	13.03	2.33	2.51	139394	0.032*	0.073

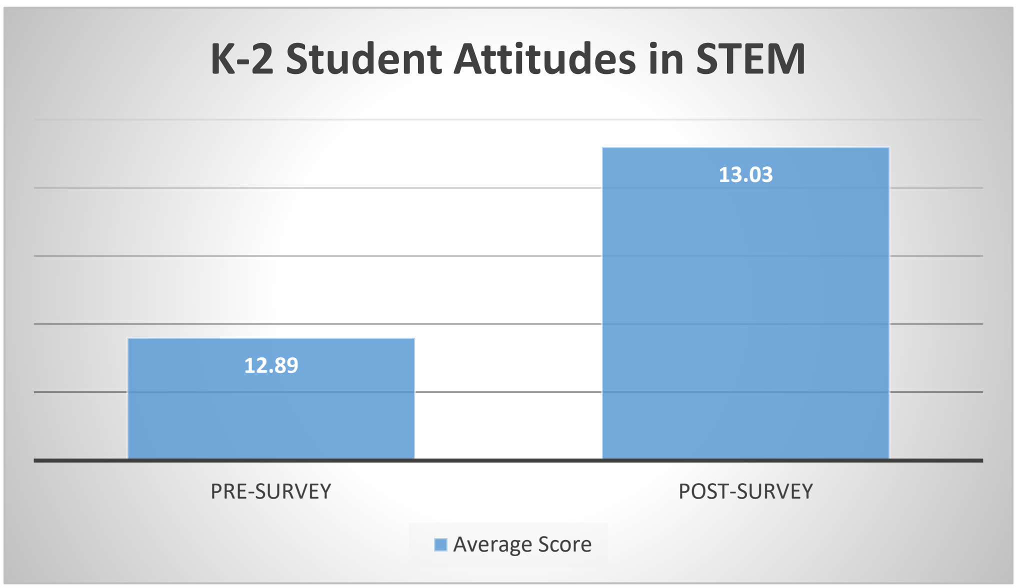


Figure 1: K-2 Attitudes Comparison

The second analysis was applied to Question 6 of the survey. The question asked students to select the activity they liked best: science, computers, math, or building. A chi-square test was applied to the data to determine if the number of students selecting one subject over another changed from pretest to posttest. Results indicate no significant changes in which activity students liked best from pre-survey to post-survey ($N = 1045$; $X^2 = 3.117$; $p = 0.374$). See Table 2 for additional data resulting from the analysis.

The results of the analysis, however, indicated students prefer activities involving computers the best and math the least, with both science and building in the middle. Teachers and educational partners could capitalize on these natural interests by building technology pieces into their instruction in meaningful ways. Although students do prefer activities that involve computers that is not to say that computer programs should take the place of authentic investigations, but the programs should instead serve as a tool to complete investigations in STEM subjects. Science and engineering are closely linked; the Next Generation Science Standards (NGSS) require teachers at all grade levels K-12, to integrate them in authentic, meaningful ways into daily instruction. The NGSS go beyond content acquisition by requiring students to perform science and engineering tasks that become increasingly more complex as students progress through grade levels. Students starting in kindergarten are naturally inquisitive and providing materials, programs, and training to teachers that foster that natural curiosity piques student interest and desires to solve problems and explore STEM topics that would not otherwise be done through traditional didactic methods. The contingency table below (Table 3) provides percentages of students who selected each activity as their favorite for both pre-survey and post-survey.

Table 2: Contingency Table - Favorite STEM Subject

	Percentage Within Column		**Overall**
	Pre-	**Post-**	
Science	29.5	25.7	27.7
Computers	39.6	38.8	39.2
Math	9.9	10.8	10.3
Building	21.0	24.7	22.8

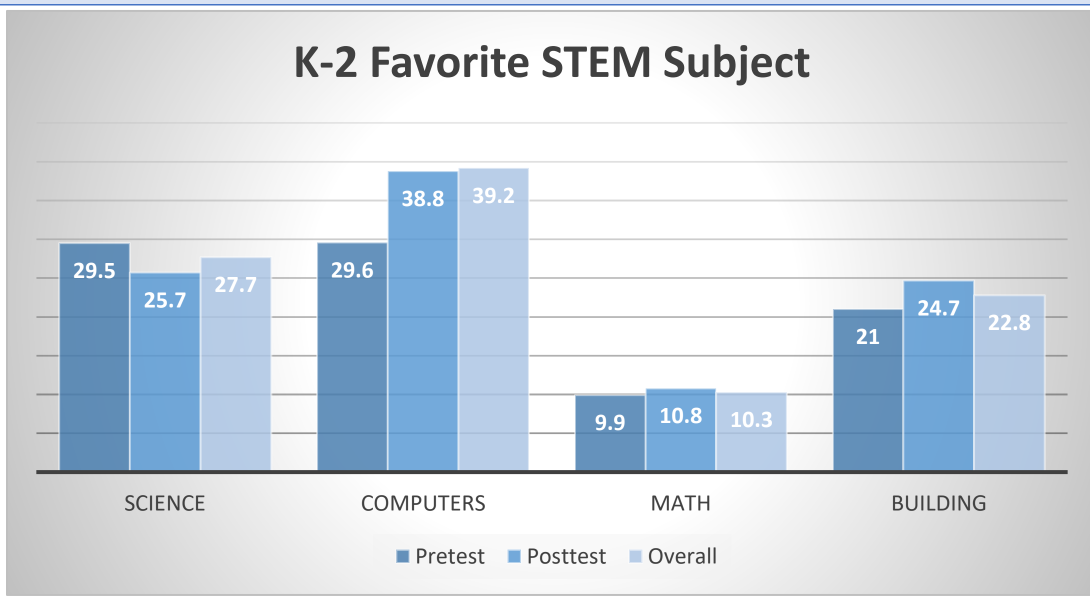


Figure 2: K-2 Favorite STEM Subject

Third Through Fifth Grade Survey Results

Students in third through fifth grade received a Student Interest and Attitudes about Science and STEM Survey consisting of 12 questions. The first seven items in the survey were single response, Likert style items encompassing how students felt they could perform in school and in STEM subjects. The remaining five items were select all that apply responses consisting of topics surrounding what subjects and careers students may want to pursue in secondary education settings and later in life when they consider career choices. Students received the survey as a pretest before any instruction occurred utilizing materials purchased with funding received from the grant, and as a posttest after instruction with the purchased materials occurred. Results of the two testing administrations were compared to determine if changes occurred, as a possible result from the use of STEM materials and kits purchased through the grant.

As with the Grades K-2, a Mann Whitney U was applied to the data to determine if differences in students' perceptions exist between the pre-survey and post-survey. Data from 984 pre-surveys and 954 post-surveys were analyzed and resulted in a post hoc power greater than 99% suggesting accurate results from the analysis. Results from Questions 1-7 surrounding students' own beliefs about their abilities to succeed in school and in STEM subjects indicate an increase in overall perceptions and interest in school and STEM subjects or activities from 10.08 points to 13.24 points with a large effect size (mean pretest = 10.08; mean posttest = 13.24; $p < 0.001$; $r = 0.702$). This increase of 31.5% in student self-perceptions suggest that when students are engaged in STEM their interest in STEM careers increases. STEM education is important for the next generation. As one teacher stated, "It's a circle and you always want to keep making things better so that when they [the student] go into that profession, and thinking about STEM, they know that it's going to be a lot of fails before there's [*sic*] successes." Students' perceptions and interest toward their abilities in school overall and in STEM subjects increased to the point that would suggest providing these materials and funding STEM activities could make a lasting impact on student's interest in school and STEM careers. Additional data for this analysis can be found in Table 3.

Table 3: Student Perceptions Towards STEM and School Abilities

	N		***Mean***		***SD***		***W***	***p***	***r***
	Pre-	**Post-**	**Pre-**	**Post-**	**Pre-**	**Post-**			
3-5 Perceptions	984	954	10.08	13.24	2.66	1.43	139918	< 0001*	0.703

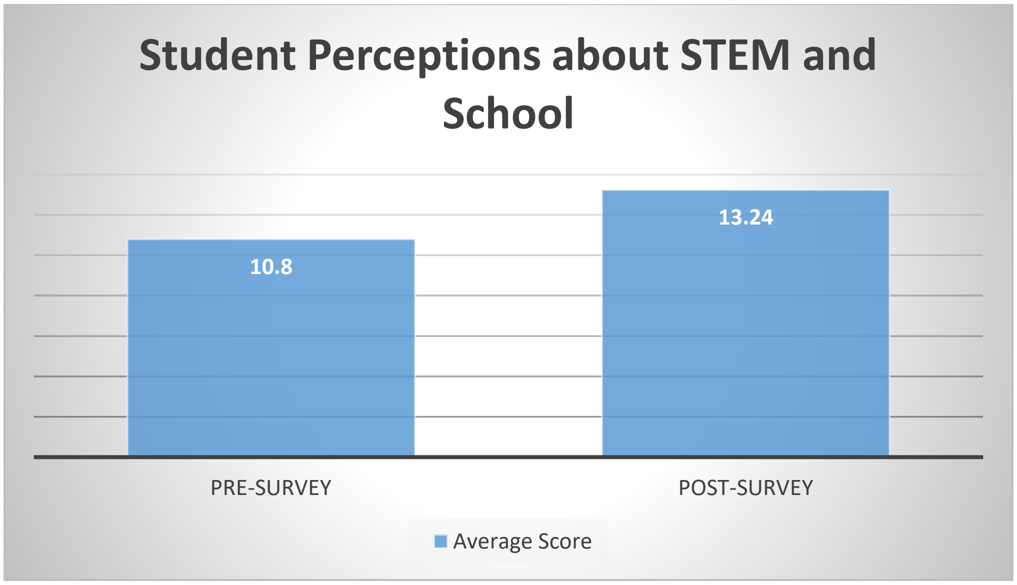


Figure 3: Student Perceptions About STEM and School

Questions 8-12 required students to select the statement and select all that applied. The frequency of each choice being selected for each question was compared from pre-survey to post-survey to determine if differences in what students selected changed over the time the materials purchased through the grant were used. Each question was analyzed separately using a chi-square analysis. A brief discussion of the results for each question follows with supporting tables.

Question 8 asked students to select which STEM subjects interested them in school. Results of the chi-square analysis suggested no changes were found between pre-survey and post-survey ($X^2 = 2.046$, $p = 0.563$). Overall students were most interested in science with technology and math tied for second and engineering was last. This lack of interest in engineering could be the result of a lack of understanding of what engineering is. The old Nevada State Science Standards did not include engineering, and before the adoption of the NGSS most teachers had no pedagogy or knowledge about engineering or how to teach it. The adoption of the NGSS has clear performance expectations for students in engineering; however, a lack of training in the NGSS and engineering specific pedagogy have left many teachers struggling with how to implement engineering in their classrooms. See Table 4 and Figure 4 for additional details.

Table 4: Question 8

	Percentage Within Column		Overall
	Pre-	Post-	
Science	30.5	28.9	29.7
Technology	23.9	25.0	24.4
Engineering	20.4	21.6	21.0
Math	25.2	24.6	24.9

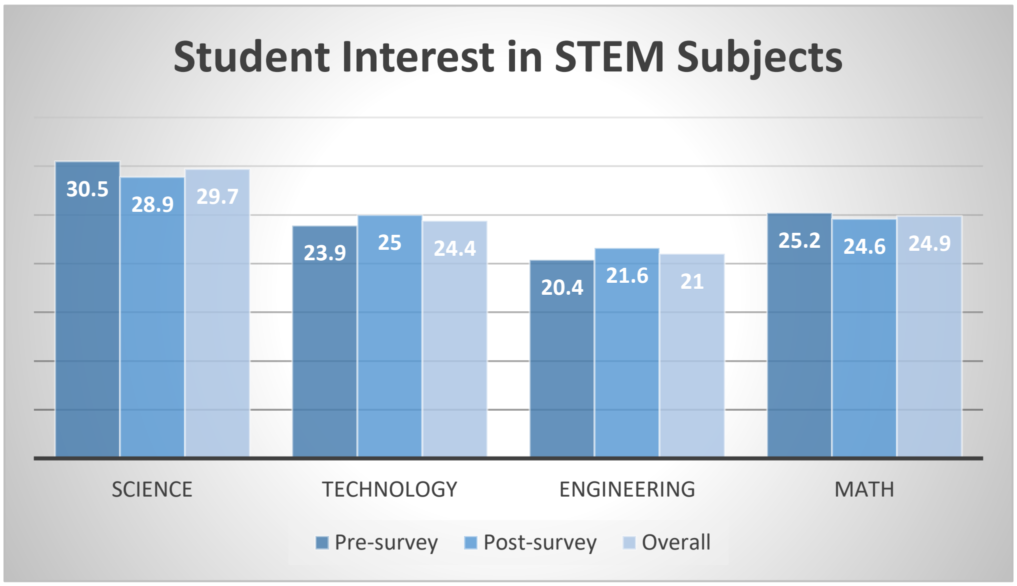


Figure 4: Question 8

Question 9 asked students to identify which STEM subjects helped them to be successful in school. Results of the chi-square analysis suggested that by the post-survey significantly more students thought engineering could help them succeed in school ($X^2 = 12.87$, $p = 0.005$). Although engineering was not the highest ranked STEM subject in either the pre-survey or post-survey, it was the only subject that had significant increases in students selecting that option from pre-survey to post-survey. This suggested students who encountered lessons utilizing or teaching engineering might see the value it can bring to their school careers. As one teacher stated, "Besides the engagement and the teamwork, they're learning what engineering means, and I'm loving that they are transferring it to other genres." Additionally, a decrease in students who selected math as a subject that could help them succeed was found from pretest to posttest. It is difficult to determine why less students selected math in the post-survey compared to the pre-survey; however, the results may point to a disconnect between math and its application in real-world situations.

Table 5: Question 9

	Percentage Within Column		Overall
	Pre-	Post-	
Science	27.7	26.0	26.8
Technology	17.6	19.6	18.6
Engineering	14.0*	17.4*	15.7*
Math	40.8*	37.0*	38.9*

Note. * Denotes significant differences between presurvey and postsurvey*

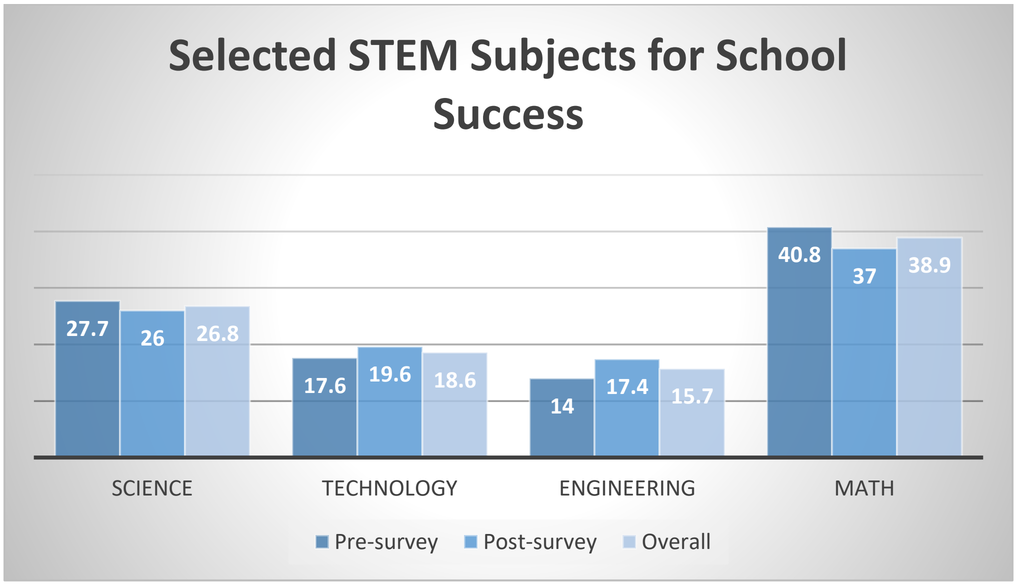


Figure 5: Question 9

Question 10 asks students to select which STEM subjects they would like integrated into their future careers. No differences in frequencies were found between pre-survey and post-survey ($X^2 = 2.215$; $p = 0.529$; $r = 0.026$). The most selected option for both pre-survey and post-survey was technology and the least selected option was engineering.

Table 6: Question 10

	Percentage Within Column		Overall
	Pre-	Post-	
Science	25.3	23.7	24.5
Technology	27.1	29.3	28.2
Engineering	22.9	22.8	22.8
Math	24.7	24.3	24.5

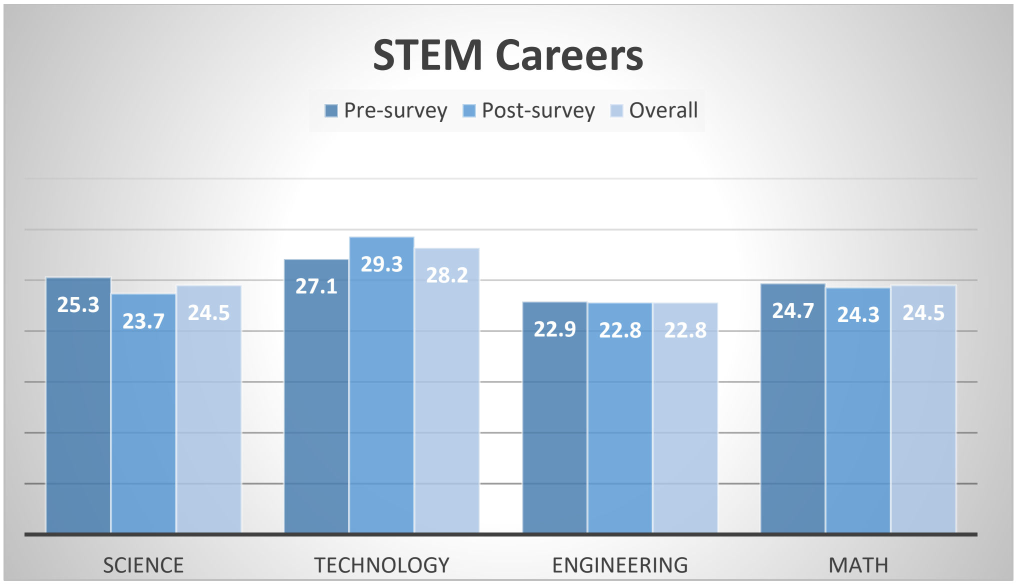


Figure 6: Question 10

Question eleven asked students to select which professions they would like when they grow up out of 12 options ranging from STEM professions to teachers, actors, and musicians. No differences were found from pre-survey to post-survey in student selected professions (X2 = 6.202; p = 0.860, r = 0.040). The most selected options were athlete, engineer, teacher, and doctor.

Table 7: Question 11

	Percentage Within Column		Overall
	Pre-	**Post-**	
Doctor	11.4	11.2	11.3
Actor	9.1	8.6	8.8
Biologist	4.0	4.3	4.2
Veterinarian	10.1	10.0	10.1
Musician	7.6	7.7	7.7
Computer Specialist	7.6	7.2	7.4
Athlete	15.0	14.6	14.8
Engineer	12.4	12.2	12.3
Teacher	11.5	11.1	11.3
Accountant	1.4	1.9	1.6
Physicist	1.9	2.8	2.3
Technology Specialist	7.9	8.3	8.1

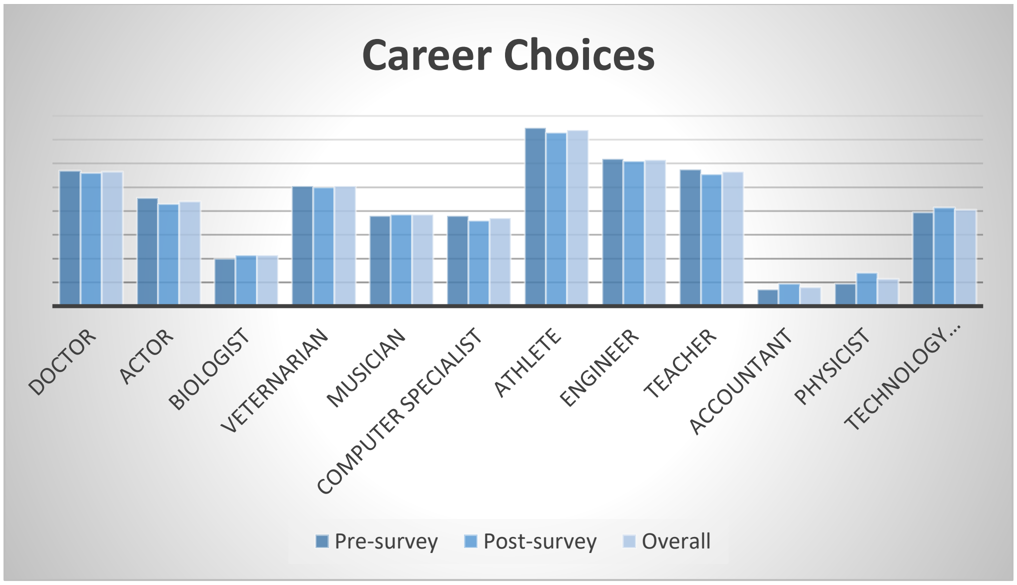


Figure 7: Question 11

Question 12 asked student to select their favorite part or subject of the school day. No significant differences were found from pre-survey to post-survey ($X^2 = 17.94$; $p = 0.056$, $r = 0.047$). P.E., art, and math were selected most often, and social studies and library were selected least often.

Table 8: Question 12

	Percentage Within Column		Overall
	Pre-	Post-	
P.E.	13.2	12.1	12.6
Math	9.2	8.7	8.9
Science	9.0	9.0	9.0
Reading	7.8	8.4	8.1
Recess	11.1	9.4	10.2
Computers	9.1	8.6	8.8
Art	12.6	12.7	12.7
Writing	6.3	6.8	6.6
Library	5.7	7.1	6.4
Social Studies	5.6	5.7	5.7
Lunch	10.6	11.5	11.1

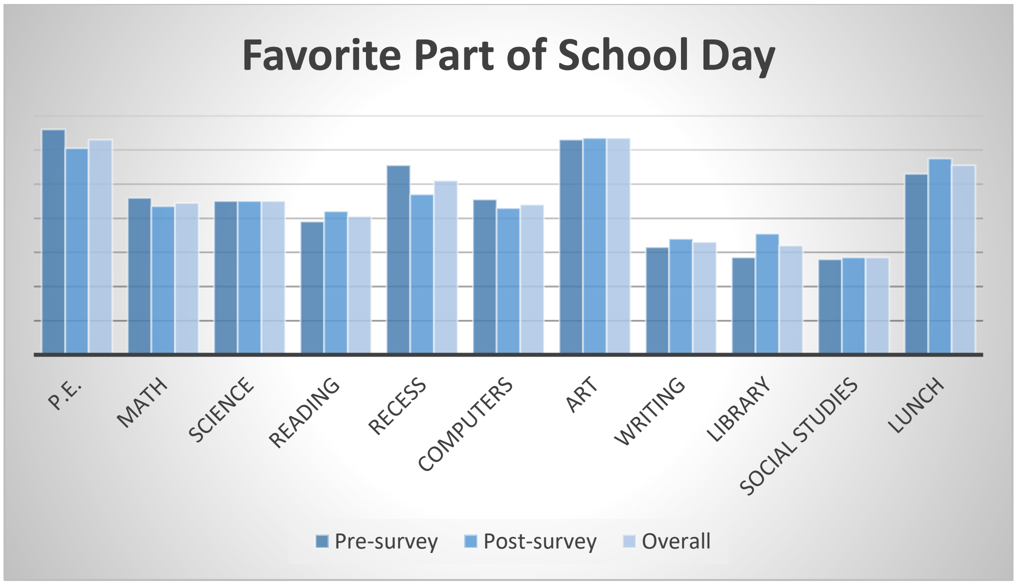


Figure 8: Question 12

Student Content Knowledge

Teachers who received program level funding were required to create or administer a content test to their classrooms as well as the survey. The assessment only needed to cover the content the students engaged in. Comparing results from different assessments required the data to be transformed into a *Z* score for comparison using an independent samples *t*-test. Results of the analysis suggest a significant improvement from pretest to posttest with a very large effect size ($p < 0.001$; $d = 2.076$). This suggests the methods employed by the teachers were sufficient for students to access and comprehend the content being covered in the purchased kits. One teacher stated that the program helped the students who frequently struggle "One of my lower kids that I was not expecting much growth [on the content test] from, zero to three, which would be considered, for me that I would consider that achieving what I wanted him to achieve. And they loved it, to me that was the best part." See Table 9 for additional details.

Table 9: Content Results

	N		***Mean***		***SD***		***t***	***p***	***D***
	Pre-	**Post-**	**Pre-**	**Post-**	**Pre-**	**Post-**			
Content	532	478	1.378	3.556	0.866	1.220	34.35	< 0001*	2.076

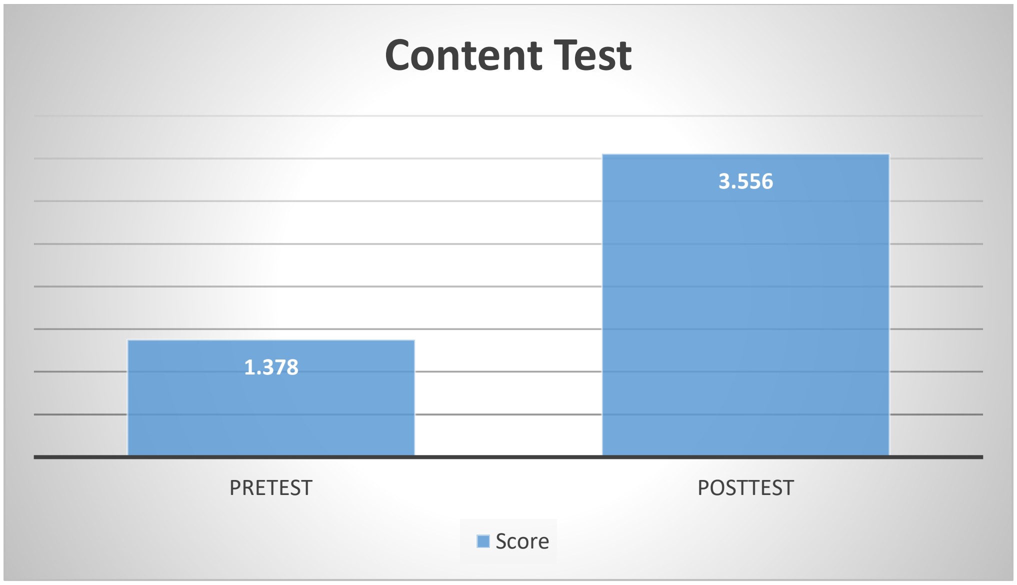


Figure 9: Content Results

Teacher Sense of Self-Efficacy

The Science Teaching Efficacy and Beliefs Instrument for in-service teachers (STEBI-A) was used to determine if teachers sense of self-efficacy or outcome expectancies for student performance in science education changed from pretest to posttest. The assessment measures two different constructs (1) self-efficacy, and (2) outcome expectancies. All participating teachers were asked to take the STEBI-A anonymously through SurveyMonkey.com before they received any materials or professional development purchased with funds through the grant, and after they taught at least one lesson using materials purchased through the grant. Eighty-two teachers took the pretest, of whom 56 were involved in program-level funding, and 26 received classroom level funding. Fifty-six teachers took the posttest, of whom 24 were involved with program level funding and 32 received classroom level funding. A post hoc power analysis was conducted resulting in a power of 0.88 for a Mann-Whitney U analysis. The high power suggested the results are reliable and not due to error. No changes were found in either construct. This could mean that teachers already held high expectations for their students and those expectations were maintained throughout the program. One teacher stated, "I feel like they'll just be really awesome problem solvers in the future and being able to solve any problem they encounter" when asked about the expectations of the program materials. It could also mean that teacher expectations for their students were low and the implementation of the programs did not change their ideas. "I personally don't have a lot [of expectations] yet." stated another teacher. The lack of change could be the result of a lack of training in the materials or kits purchased. Although materials were provided, an integral component to change self-efficacy and beliefs about student performance revolves around preparing teachers to adequately use the materials and feel comfortable diving into resources that may not have been used before.

In order for teachers to increase their self-efficacy in teaching science or increase their expectancies for students in science education, teachers must be provided with more than just materials; they also need the training as well as time to implement and use the resources provided. However, even with the lack of training, teachers were still eager to implement the programs. Many commented about their reason for teaching STEM. "I want to educate myself as much as I can, so I feel my confidence build" stated one teacher. Many of the teachers stated they did not feel comfortable teaching science or technology and tended to gravitate toward training activities to increase confidence. Some teachers reported that they were willing to restructure their day to fit STEM implementation into their busy schedules. "My kids couldn't wait for science. We chose to do science all week and usually I only do it two to maybe three times during the week." See Table 10 for additional data.

Table 10: STEBI-A

	N		***Mean***		***SD***		***W***	***p***	***r***
	Pre-	**Post-**	**Pre-**	**Post-**	**Pre-**	**Post-**			
Self-Efficacy	82	56	28.85	26.93	7.61	7.51	2661.5	0.113	0.159
Outcome Expectancies	82	56	29.11	27.82	5.57	5.50	2617.0	0.164	0.140

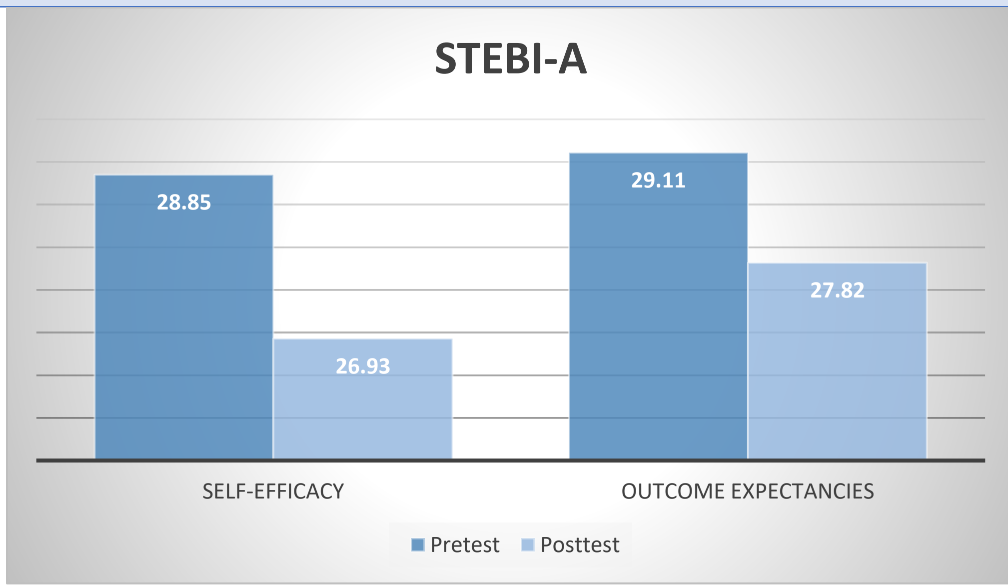


Figure 10: STEBI-A

Barriers to STEM Education in the Elementary Setting

The pre- and post- focus group sessions uncovered a few barriers that were consistent amongst the groups. Issues discussed included lack of professional development (PD), lack of time, and lack of materials. All three components seemed to be required to assist teachers in becoming more comfortable with science and STEM teaching. The program funding addressed the lack of materials and attempted to address the lack of PD, in that funds could be used to pay for PD. Unfortunately, these barriers did not change from pre- to post- sessions. Participants gave the following reasons for the lack of STEM education in the elementary setting. The perceived barriers were time, science/STEM content knowledge, science/STEM professional development and training, technology availability, and student abilities in technology and cooperative tasks.

Time was mentioned by nearly every participant in both the pre- and post- focus group sessions. "There isn't enough time" was stated by at least one member of every group with multiple affirmations by others. One teacher reflected that there is a mandated time for science in her district, but it does not allow enough time to really get into science problems. Fellow participants noted that there is a mandated time for explicit subject instruction, including science, and they agreed that the mandated science time was insufficient. However, for teachers who had freedom to change the structure of their school day, the materials assisted them with integrating their curriculum, and therefore, finding more time in the school day. One teacher explained how she was able to integrate her subjects more effectively, "We've been in [the materials] exploring it, talking about how to take care of the earth in all different ways and with art and writing and different things, not just the kit."

The structure of a school day and required time for other subjects meant that, for some districts, science and STEM education time was often relegated to the end of the day or one day a week. This led to situations where the allotted time could be cancelled or too much time would go by between lessons, leading to wasted time refreshing previous information. When discussing the use of the supplemental program materials, a teacher stated, "We don't necessarily have to teach it [STEM]. It just kinda goes along with what we're teaching. Because we do it Friday, and then they don't again until the next Friday, so sometimes there's a gap." This statement reflected the teacher's thinking that, not only is STEM perceived as a supplemental activity, but also that only participating in STEM education once per week does not allow students to develop a good understanding of the topic. She continued to explain that though the students perform well on the STEM activity, because so much time passed between lessons, there was confusion the following week on the same topic. One difficulty cited by a group was that the program was only available to be used during a specific time once per week because the school could not afford enough kits for all teachers. The educators in this group perceived that there was not enough time in the day or days in the week for science and STEM to be an everyday part of the curriculum. Many districts require specific time amounts for explicit skill instruction per subject area. This practice does not allow for truly integrated instruction which would provide the needed time for the teaching of science and STEM.

Another aspect of the lack of time was found in the actual instructional time and preparation time allotted for the program lessons. Many participants complained that the guides for the lessons were frequently incorrect or inconsistent when giving directions on preparation or instructional time. This complaint was most frequently cited among groups that had little training in the materials. Some teachers felt that the lessons took much longer to prepare and institute which led to some frustration. For example, one teacher stated, "I felt like I could have done it [one lesson] in five minutes and then other lessons, it took us 45 minutes. And then we still didn't get to all of what they wanted on the thing [lesson].” She continues with “there was a lot of figuring things out still I feel like with them [students], but it's a new kit.” These frustrations could have been eliminated with additional training and familiarity with the programs. It should be noted that teachers tend to set aside specific amounts of time for science, either mandated or by choice. When a lesson is shorter or longer than expected the teacher must quickly adapt, this can lead to stress and unwillingness to use the materials. Even though instructional and preparation time were still considered barriers to STEM education, nearly all the educators agreed on the importance of science and STEM education and did their best to make time for the program. One teacher’s positive remark was that the program led to “more science in the classroom. Which is always great.” Other teachers made positive comments regarding their students, such as, “They loved it” and “They're engaged; they're absolutely engaged.” These types of positive feedback showed teachers’ understanding of the importance of STEM education and the willingness to teach STEM when given the materials and time.

Nearly all the teachers perceived that their personal level of content knowledge and training was insufficient to feel comfortable during STEM time. Some teachers felt that they had received adequate training in science during their teaching programs and many felt they had received some science in college. One teacher mentioned, “It was just one class [science] and that was it. So I could have used more.” This general lack of content knowledge appeared to impact teachers’ comfort level in teaching science/STEM. Most of the educators perceived that their districts had done little to help them in science/STEM training and were left on their own to figure it out. One teacher stated, “Not being a science teacher,… I feel like sometimes there’s not enough to know the direction that [the program] is going, and I Google some stuff.” When discussing science/STEM training “I haven’t had any [training]” was a frequent answer. This feeling was less prevalent in districts or schools that had a dedicated science coordinator or specialist, who were usually praised for providing the participants with some assistance. However, when discussing training on the Nevada Academic Content Standards for Science (NVACSS) nearly all the participants thought that the Nevada Department of Education (NDE) had done a half-day of training a few years ago. The underlying feeling seemed to be that more training needs to be provided by the state or districts. The post-focus group answers did not change the perspective on STEM training, as most of the equipment and materials did not utilize professional development (PD) from the curriculum designers. Three different programs were chosen by schools. Only two of the program grantees receive training from the curriculum developers. One program grantee asked the Regional Professional Development Program (RPDP) to assist in PD, although the coordinator was unfamiliar with the program. These teachers met with the RPDP coordinator for an afternoon session. One district worked in collaboration with the designers to improve premade STEM kits, and the other two relied on their science teacher/coordinator(s) in their district for help with the materials. Many of the participants reported frustration with the materials, feeling that the instructions and directions were unclear or did not make sense. This feeling occurred more frequently with the programs that did not purchase the professional development that was offered with the kits. One teacher who received minimal training stated, "One time through it and you'll figure it out as a teacher but [the] first time you open the kit and use it, [it felt] just a little disjointed in terms of how to structure your lessons and how much time would be included in each chunk." Professional development and training were needed to reduce frustration and wasted time.

Although not as prominent in the pre-focus group interviews, lack of available technology and technology training were considered barriers to STEM education during the post-focus group interviews. This perceived barrier could be because the teachers who had these struggles specifically had programs that related to technology. In particular, some of the educators using a technology-based program stated there was no enough technology in the school. A similar struggle occurred with another group that chose to work with the coding and robotics lessons within their STEM kits. In this case, connection and conductivity were a problem with in the buildings, compelling teachers to find ways to work around these issues. As one teacher stated due to a connection issue, "the kids didn't have fun." She continued with stating that once she got the technology (coding blocks) working, she only had her phone that would connect to the blocks and that made the lesson difficult. Some teachers felt that their personal level of technology understanding was lacking and therefore, they were less able to solve the issues with the technology. Many teachers felt that student understanding of technology, and other 21st century skills, were needed for their students to be prepared for STEM careers.

Student preparation for collaborative learning was also cited by teachers. "The students need a great deal of preparation in order to meet the expectations. You've gotta go [teach] from the very minute, all the way up to the more complex, or else they're not gonna be able to do it," said one teacher who clearly understood that STEM education must start at the youngest grades so that students are prepared for harder tasks in the upper levels. "They've got to be trained on working collaboratively" and similar statements were frequently given when asked, "What can teachers do to help train the next generation of STEM professionals?" Another participant answered the question by stating, "I don't just want the answer I want to know how you [the student] got to the answer because being able to explain yourself in that math problem means you'll be able to explain when somebody else asks a question about whatever else." Many teachers felt that the students tried to give the teacher the expected answer rather than thinking on the problem and finding a solution. The program materials were cited, during post-focus group discussions, as helping students become more collaborative and willing to figure things out. For example, regarding one particular lesson using Morse code, a teacher stated, "What I noticed when I walked in and we have Morse code going off was that everybody in the classroom was engaged; everybody was having conversation [and] that wouldn't have happened outside of that activity." Another teacher reflected that, "I think that the kids are beginning to understand that kind of thinking, problem solving and collaborative thinking." Using STEM-related materials in class allowed students to improve their skills in problem-solving, collaboration, and discourse.

Teacher Perceptions of Changes to Classroom Culture

During the pre-focus group interviews, many of the program grantee participants were only aware that their school had been selected to receive the funding, but they were not aware of the program they were receiving. The teachers frequently responded to the question, "Why did your group selected this program?" with the answer that they did not know how the program was selected or that administration chose the program. However, even in the schools where the program was chosen by administration or science/STEM coordinators, teachers still opted to participate and frequently stated high expectations for student engagement. As one enthusiastic teacher stated that she was very excited and looking forward to the opportunity to teach the different parts of STEM, not just the science. "We don't get to do the technology, engineering, and the math part of it and put[ting] it all together so I'm hoping to have some really interactive kits from the end of the year for my kids to be able to use and explore" she exclaims.

The post-focus group interviews showed that the expectations for student engagement were met, even if a program was difficult for the teacher to institute in class. For the majority of the teachers, the programs helped engage students in the building of things, which led to improvements in sense making and asking good questions. One teacher stated that exposing students to and prompting student questions through exploration were good ways to foster creative thinking and the ability to make connections. Additionally, teachers felt that students were associating school activities to STEM careers. For example, one teacher stated, "my kids actually knew what an engineer was, after. That was kind of exciting. They were like, 'Oh, maybe I could do that! I love building things.'" Teachers also expressed that cooperation and collaboration increased as the students realized that failure was part of the process, "that it's okay for things to not go right, that they can test it and try again and keep going." Most participants reported that their students loved to work with the program materials. "My kids really liked the hands-on [aspect], being able to be that engineer, being able to use their thought process, being able to use it in a group and get up and walk around and move and do things with it" reported a participant. Team-work improvement was also cited from the participants. Students began to understand that their individual ideas might not always be the best. For instance, "they had to be thinking like engineers and build on each other's thoughts a little bit more and ideas and be respectful in their disagreements and be okay with maybe their idea [*sic*] is not the one that's used" stated one participant.

Conclusions

The materials received by the program grantees resulted in students and teachers enjoying STEM education. While significant barriers to STEM existed, including training, time, and materials, teachers still wanted to work STEM into their classrooms. As one teacher stated, "I chose to work with the STEM kit because we have great science kits, but it doesn't cover everything." The participants of this study understood that STEM is important and needed in today's schools.

The evaluation showed that providing materials to teachers and their classrooms can increase students' interest and awareness of STEM professions. It should be noted, however that simply providing funding for materials does not necessarily increase teacher comfort in teaching STEM. The teacher self-efficacy and outcome expectancy did not change by just receiving or using the materials. However, the teachers believed in the programs and reported changes to their classroom even if their overall self-efficacy remained the same. Changing teacher practice requires more than just materials; time and professional development are essential.

Training must be a part of the solution to improve STEM education in the elementary grades. Additionally, both instructional and preparation time continues to be the main barrier when instituting STEM education. This cannot be solved through funding materials alone. The school day is a set amount of time and teachers need training in how to create interdisciplinary lessons so that there will be more time available for science and STEM education. Furthermore, teachers need the freedom to structure these interdisciplinary lessons in their classrooms without interference from the time requirements of siloed subjects, which were frequently cited as the reason there was little time for STEM.

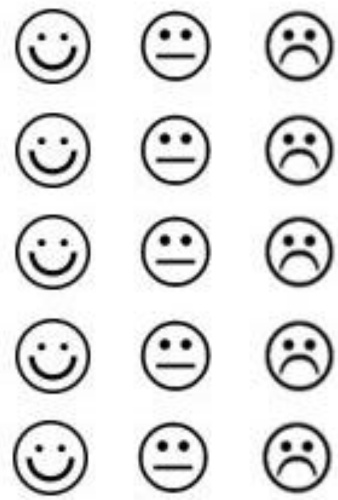
Appendix A

Student Interest and Attitudes in Science and STEM

K-2 grade

For each question, circle one face to show how you feel about each sentence.

1. Doing **activities** in class makes me feel…
2. Doing **science** in class makes me feel…
3. **Building** things in class makes me feel…
4. Doing **math** in class makes me feel…
5. Using **computers** in class makes me feel…



Circle the activity you like <u>BEST</u>:

Science

Computers

Math

Building

Student Interest and Attitudes about Science and STEM

3-5 grades

Questions 1-7: Read the statement and choose *one* answer.

	Yes	No
1. I am interested in school.	☐	☐
2. I can get good grades in school.	☐	☐
3. I am interested in doing more hands-on activities in class.	☐	☐
4. I like to create new things.	☐	☐
5. I am interested in building and fixing things.	☐	☐
6. I think I can do well at college.	☐	☐

7. Learning something new is... ☐ Easy ☐ OK ☐ Hard

Questions 8-11: Read the statement and choose *all* that apply to you.

8. I am interested in school when we learn...

☐ Science ☐ Technology ☐ Engineering ☐ Math

9. Learning __________ helps me succeed in school.

☐ Science ☐ Technology ☐ Engineering ☐ Math

10. I would like a job that includes...

☐ Science ☐ Technology ☐ Engineering ☐ Math

11. I would like to be a __________ when I grow up

☐ Doctor ☐ Veterinarian ☐ Athlete ☐ Accountant
☐ Actor ☐ Musician ☐ Engineer ☐ Physicist
☐ Biologist ☐ Computer Specialist ☐ Teacher ☐ Technology Specialist

12. In school, I enjoy__________ the best.

☐ PE ☐ Science ☐ Recess ☐ Art ☐ Library ☐ Lunch
☐ Math ☐ Reading ☐ Computers ☐ Writing ☐ Social Studies

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