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EVALUATING THE EFFECTS OF STEM OUT-OF-SCHOOL TIME PROGRAMMING ON THE DEVELOPMENT OF STEM ATTITUDES AND 21st CENTURY SKILLS OF COMMUNITY SCHOOL STUDENTS

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EVALUATING THE EFFECTS OF STEM OUT-OF-SCHOOL TIME PROGRAMMING ON THE DEVELOPMENT OF STEM ATTITUDES AND 21st CENTURY SKILLS OF COMMUNITY SCHOOL STUDENTS

A DISSERTATION APPROVED FOR THE DEPARTMENT OF INSTRUCTIONAL LEADERSHIP AND ACADEMIC CURRICULUM

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DEDICATION

To the memory of three individuals who would have loved to read this dissertation. Though they are gone, their belief in me has been a sustaining force throughout my entire graduate school journey.

To my father-in-law, Daryl Latta, who taught me how to value and build community.

To my grandmother, Juanita Jernigan, who was my first teacher and who instilled in me a passion for education.

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Table of Contents

List of Tables

List of Figures

PROLOGUE

This dissertation adheres to a journal-ready format. Three journal articles prepared for submission to refereed journals comprise the first part of the dissertation. Manuscript I, Students', Parents', and Teachers' Perceptions of Outcomes Related to STEM Out-of-School Time (OST) Programs in a Community School is prepared for the *American Educational Research Journal.* Manuscript II, Evaluating Out-of-School Time (OST) Program Outcomes Associated with 21st Century Skills is prepared for the journal, *Afterschool Matters*. Manuscript III, The Effects of STEM Out-of-School Time Programs on the Development of STEM Attitudes and 21st Century Skills of Community School Students is prepared for the *Journal for Research in Science Teaching*.

Dissertation Abstract

National attention has turned to the provision of high quality science, technology, engineering, and mathematics (STEM) instruction to help prepare students for the 21st century workforce. To promote innovation, creative instructional practices are required. Community schools implement out-of-school time (OST) programming as a part of a core instructional program to support student engagement, extend student learning, and pique students' interests in a variety of topics not typically covered during the regular school day. STEM OST programs provide students with opportunities to experience all those benefits in addition to the development of learning surrounding various STEM topics like coding, robotics, engineering, etc. This convergent mixed-methods study, set within a Title I community school, sought to identify how STEM OST programs influence students' attitudes toward STEM as well as 21st century skills. The study incorporated the perceptions of parents, students, and teachers regarding student outcomes from OST programs. Students who participated in STEM programs demonstrated an increase from pre- to post-test scores on a survey measuring STEM Identity. Students who participated in Non-STEM programs demonstrated a pre- to post-test increase on a survey of 21st century skills. Parents, students, and teachers perceived a variety of different 21st century outcomes associated with program participation, including the growth of learning and innovation skills, relational skills, and social emotional skills. Implications for practice are discussed.

Keywords: Out-of-school time (OST) programs, community schools, STEM, 21st century skills

MANUSCRIPT I

Students', Parents', and Teachers' Perceptions of Outcomes Related to STEM Out-of-School Time (OST) Programs in a Community School

This manuscript is prepared for submission to the peer-reviewed journal, *American Educational Research Journal*, and is the first of three manuscripts prepared for a journal-ready doctoral dissertation.

Abstract

Providing STEM out-of-school time (OST) programs in a community school setting gives students opportunities to learn about STEM-related concepts that fall outside of the regular curriculum. Using data from a qualitative case study conducted at a community school, this study identified outcomes related to participation in OST programs. Based on feedback from students, parents, and teachers, STEM OST programs promoted positive STEM attitudes, 21st century skills (specifically learning and innovation skills), cultivation of new interests, the development of process skills, and increased relational intelligence and social skills among peers. Instructional and program-specific implications are discussed in an effort to support both in-school and OST programs.

Keywords: Community School, STEM, out-of-school time (OST) programs, 21st Century Skills

Students', Parents', and Teachers' Perceptions of Outcomes Related to STEM Out-of-School Time (OST) Programs in a Community School

In a society driven by innovation, careers in the areas of Science, Technology, Engineering, and Mathematics (STEM) are more in demand than ever before (Carnevale, Smith, & Melton, 2011). In recent years, there has been a national emphasis on the provision of high-quality STEM programming in U.S. schools supported by the 2013 release of the Next Generation Science standards for kindergarten through 12th grade students (McClure et al., 2017). These standards include rigorous science practices, core science ideas, and interdisciplinary connections for classroom instruction (NGSS, 2013). In addition to the regular curriculum, out-of-school-time (OST) programs provide students with opportunities to make choices about their learning, cultivate new interests, and deepen their understanding about specific STEM content areas (Allen et al., 2017). These programs offer activities that promote 21st century skills like critical thinking, creativity, communication, and collaboration (Sahin & Ayar, 2014).

One challenge associated with the provision of OST STEM programs is identifying measures of program success related to student outcomes. Considering that students' grades and test scores are associated with a variety of different school variables outside of the program, these measures are not appropriate for determining program success (Wilkerson & Haden, 2014). While survey-based measures of student attitudinal change toward STEM concepts over time are commonly recognized as appropriate measures of the effects of STEM after school programs (Krishnamurthi, Ballard, & Noam, 2014; Malyn-Smith, Cedrone, Na'im, & Supel, 2013), they do not always capture the nuance and holistic perceptions of program participants, their families, and their teachers. Focus groups and interviews offer program providers the ability to identify program strengths, challenges, and outcomes in a personal and conversational way that can complement survey measurement (Merriam & Tisdell, 2016).

Problem and Research Questions

For one public community school in the Midwest, *STEM Academy* (pseudonym), identifying program outcomes was a very real challenge, especially considering that sharing these outcomes with community partners was important for continued OST program support. With community embedded in the identity of the school, student, parent, and teachers contributed directly to answering the three research questions for the project:

1. For students at a community school, how do STEM related OST programs influence their attitudes toward STEM learning?
2. How do STEM related OST programs influence the development of 21st century skills?
3. What outcomes do students, parents, and teachers perceive from student participation in STEM related OST programs?

Background

Community Schools

Community schools promote a comprehensive, four-part approach, providing layered supports for students and families (Maier, Daniel, Oakes, & Lam, 2017). The philosophical backbone of community schools includes the provision of "integrated student supports, expanded learning time and opportunities, family and community engagement, and collaborative leadership and practices," (pp. v). These four areas promote equity and a comprehensive set of services for students and their families. This is especially valuable for underrepresented families who experience poverty (National Center for Community Schools, 2011). By partnering with surrounding organizations (businesses, faith-based organizations, medical groups and facilities, etc.) community schools are able to provide for the unique needs of the community within which the school is situated. Additionally, they seek to fill the void of access to rich STEM experiences through the equitable provision of high-quality in-school and OST programs for all students and families.

STEM OST Programs

As one of the critical pillars of community schools, expanded learning time and opportunities (OST programs) are designed to complement and extend daily curriculum (Maier et al., 2017). The function of OST programs has changed significantly over the past few decades. Once serving as a safe place for kids to complete homework with their peers, OST programs now provide students with opportunities to cultivate new interests and take a deeper dive into learning specific skills and subject areas that may be covered briefly, if at all, in the regular school curriculum (Allen et al., 2017). STEM OST areas can include (but are not limited to) topics like robotics, coding, chemistry, and computer programming. When students enroll in these types of programs, they often enroll by choice. Hence, they can share space and time with peers who possess similar interests and with whom they can engage in collaborative learning and problem solving (McClure et al., 2017). In addition to promoting the growth of STEM content knowledge and process skills, these programs promote the development of 21st century skills.

STEM Attitudes

When it comes to learning, students' attitudes influence their interest in pursuing opportunities for deeper understanding (Kurz, Yoder, & Ling, 2015). Early interest and participation in STEM learning are critical for students who are interested in entering STEM careers (Lyon, Jafri, & St. Louis, 2012). Researchers have used the phrase *STEM pipeline* to describe the progression of STEM curriculum from early elementary through middle, secondary, and post-secondary levels. The precursor for positive attitude development is the availability of high-quality STEM program options from which students can choose (Allen et al., 2017). A diverse menu of offerings allows them to develop new interests in STEM related topics that may not be an area of focus during the regular school day. Enrollment in these programs often prompts the development of positive attitudes and new interests as students learn skills and concepts that they did not know about before.

21st Century Skills

Over the past decades, 21st century skills have become a primary focus of policy makers, educators, and professionals in STEM fields (National Research Council, 2010; Partnership for 21st Century Skills [P21], 2004; PCAST, 2010). 21st century skills include a set of dispositions and outcomes that are helpful for learning and navigating a technologically advanced society (Unfried, Faber, Stanhope, & Wiebe, 2015). These skills include life and career skills, learning and innovation skills, and information, media, and technology skills in addition to 21st century themes like global awareness and financial, civic, health, and environmental literacy (Battelle for Kids, 2019). These skills and themes are considered necessary for success in innovative 21st century professions.

Sociocultural Theory and the Interrelational Quality of the Zone of Proximal Development (ZPD)

OST programs structurally allow for the development of relationships between students and their teachers. Programs are accessible by choice, capped at a certain capacity to limit overcrowding, and run for about one to two hours before or after the school day (Allen et al, 2017; Beckett et al., 2009). The conditions are ripe for the formation of not just knowledge, but also relationships. For this reason, the most appropriate theoretical framework for the development of new learning that occurs during program time is a combination of sociocultural theory and the ethic of care (Goldstein, 1999). According to Vygotsky (1978), learning is a socially mediated process that occurs when a more knowledgeable peer or teacher presents information that is just outside of a student's developmental level (called the Zone of Proximal Development [ZPD]), which then advances a student's understanding and development to the next level. The process of knowledge development in the ZPD is referred to as *intersubjectivity* (Newson & Newson, 1975). Vygotsky's sociocultural theory has stimulated the development of countless other theories, especially because his career was cut short by his early death. Goldstein (1999) extends the theory with a more complex view of the ZPD, suggesting that more consideration can and should be given to the interrelational dimension of the ZPD (which is more commonly recognized for its cognitive nature).

Using Noddings' *ethic of care*, Goldstein (1999) explains that the transformative nature of the ZPD lies not just in the information being shared in a learning experience, but also in the caring nature of the interaction. It is in this *relational zone* that learning occurs. The relational nature of learning, Goldstein suggests, also makes it mutually transformative. The occasion of learning not only expands the understanding of the student, it supports the motivation of the teacher (*teacher* in this sense can be a peer or an adult). Teachers and more knowledgeable others adopt certain activities or techniques to scaffold learners' understanding. These may include the provision of choice and autonomy, questioning, modeling, and posing challenges that extend understanding (Bodrova & Leong, 2007). Interestingly, these are all activities commonly embedded in STEM programs, which confirms the suitability of the sociocultural theory as the theoretical framework for this study.

Methods

The purpose of this qualitative case study was to capture the perceptions of students in 1st through 5th grade, their parents, and teachers related to the outcomes of STEM OST programs via interviews (teachers) and focus group sessions (parents and students). The study, set within STEM Academy, a community school in the Midwest, sought to answer the following questions from three critically important vantage points: (1) For students at a community school, how do STEM related OST programs influence their attitudes toward STEM learning? (2) How do STEM related OST programs influence the development of 21st century skills? and (3) What outcomes do students, parents, and program teachers perceive from student participation in STEM related OST programs?

Setting, OST Program Overview, and Participants

The focus school in the study, STEM Academy, was a public, Title I community school in the Midwest. The diverse student population included 57.1% Hispanic and Latinx, 14.4% African American, 11.6% Caucasian, 7.3% Asian, 2.5% Native American, and 7.0% students with two or more races. The percentage of students who qualified for free or reduced lunch was 92.2%. Ten different native languages were represented among students. In the school year prior to the study (2017-2018), 53% of the students were involved in at least one after school program offered one to four days per week each semester. The school functioned not only as a school but also as a community hub with a fully functioning medical clinic onsite, mental and behavioral health services, and 23 free after school programs. All programs ran for ten weeks during the fall semester.

Of the 23 ten-week programs (see Table 1), 10 were STEM programs and 13 were Non-STEM programs. Teachers of the programs were either classroom teachers or staff at the school or employees of community partner agencies (i.e. health department and museums). Programs received the label of *STEM* or *Non-STEM* programs based on three pieces of evidence: teacher identification, lesson plans, and program observations. Programs were divided further by age with 1^{st} through 3^{rd} and 4^{th} through 5^{th} grade students grouped together. Students who participated in the STEM group enrolled in STEM programs and were granted spots in those programs. To ensure the similarity of the sample, those students in the Non-STEM group signed up for STEM programs initially but were waitlisted because the STEM program they requested had reached capacity. Altogether, there were five STEM programs for 1^{st} – 3^{rd} grade students (n=39), five STEM programs for 4^{th}-5^{th} grade students (n=21), four Non-STEM programs for 1^{st} through 3^{rd} grade students (n=29), and nine Non-STEM programs for 4^{th} through 5^{th} grade students (n = 28). Of the students in STEM groups, 48.3% were girls compared to 59.6% girls in Non-STEM groups. Altogether, 117 students, 24 parents, and 29 teachers provided consent to be a part of the study.

Table 1.1

OST Program Offerings at STEM Academy

Program Name	Category	Grade	Sessions per week	Number of students	Teacher type
Connect Block Art (2 sections)	Non-STEM	1st-3rd	1	15	School
4-H, Farm Fun	Non-STEM	1st-3rd	1	15	Community
Readers Theater	Non-STEM	1st-3rd	2	13	School
Camp Fire Starflight	Non-STEM	1st-3rd	1	12	Community
Sewing	Non-STEM	4th-5th	1	8	School
Origami	Non-STEM	4th-5th	1	15	School
Choir and Instruments	Non-STEM	4th-5th	1	15	School
Gardening (2 sections)	Non-STEM	4th-5th	2	20	Community
Sports Club	Non-STEM	4th-5th	1	20	Community
Running Club	Non-STEM	4th-5th	1	18	School
Camp Fire Adventure	Non-STEM	4th-5th	1	12	Community
Song Writing and Dance	Non-STEM	4th-5th	1	15	Community
Soccer	Non-STEM	4th-5th	2	23	School
Engineering with Connect Blocks (2 sections)	STEM	1st-3rd	1	15	School
Art and STEM	STEM	1st-3rd	1	15	Community
Chemistry	STEM	1st-3rd	1	15	Community
STEM Club	STEM	1st-3rd	1	15	School
Coding and Robotics 1	STEM	1st-3rd	1	15	School
Coding and Robotics 2	STEM	4th-5th	1	14	School/Community
Robotics	STEM	4th-5th	2	10	School
City Engineering	STEM	4th-5th	1	10	Community
Chess and Computers	STEM	4th-5th	1	13	School
Tree School	STEM	4th-5th	1	14	School/Community

Data Sources and Procedures

Recognizing that STEM attitudes and dispositions toward school in general are influenced strongly by students' closest family and school relationships (McClure et al, 2017), focus groups served as an appropriate method for getting direct feedback from parents and students. In addition to the student and parent focus groups, every OST program teacher (both STEM and Non-STEM) was interviewed about his or her perceptions of program outcomes. Finally, lesson plans and at least two (on average, 3) program observations per program provided helpful insight into instruction, learning, and the types of activities that yielded student learning outcomes. Each of these qualitative data collection methods helped to provide important insight about the processes associated with student learning in STEM programs, as well as the outcomes achieved from these processes.

Parent focus groups. Parent perceptions of students' participation in OST programs and STEM learning were elicited during four different focus group sessions. Of these four sessions, two focus groups were specifically for parents (n=13) of students in STEM clubs and two were for parents (n = 11) of students in Non-STEM clubs. Considering Morgan's (2013) recommendations that focus groups involve a homogeneous group of five to ten participants who engage in a structured interview with "high moderator involvement" (p. 5), each of the focus groups included at least 5 and as many as 8 parents per session.

The focus groups were semi-structured with a guide list of interview questions to help stimulate conversation in the focus group. A high level of moderator involvement helped to ensure that each of the groups was presented with and spent comparable amounts of time on the focus group questions (Morgan, 2013). Considering that many parents in the school were monolingual Spanish speakers, a bilingual translator was available for each focus group. Focus group sessions ran for about 30-45 minutes directly after OST programs in the school media center.

Data collected from the focus groups were derived from an interactive process of social construction through conversation (Merriam & Tisdell, 2015). The purpose of the focus groups was to gain understanding about why parents enrolled their students in OST programming, what academic or cognitive outcomes they perceived from their child during the program, and what changes were recommended to improve the programming. The focus groups were recorded on a portable recording device, transcribed, and analyzed. Immediately following the focus group sessions, the files were uploaded onto a computer and housed as a digital file, ready for transcription and coding.

Student focus groups. Similar to the parent focus groups, seven student focus groups (3 STEM, 4 Non-STEM; 8 students per group) were also conducted. The groups included randomly selected students from the following groups: (1st – 3rd Non-STEM, 1st – 3rd STEM, 4th-5th Non-STEM and 4th-5th STEM). For random selection, student names were input into an Excel spreadsheet, divided by age and program type, and were randomly assigned numbers with the Excel random number generator function. The first eight student names in each group were selected for focus groups. Once a student was selected for a focus group, his or her name was removed from the list to avoid duplication in another focus group.

Using semi-structured interview questions, each focus group lasted approximately 20 minutes and took place during snack time (right before the start of programs) during the eighth and ninth weeks of programming. The researcher adopted the role of participant observer (Fine & Sandstrom, 1988). Since the researcher was already part of the school community and had established familiarity with students in after school programs, this role allowed a glimpse of students' genuine thoughts without feeling that they were being evaluated by a stranger. During the focus groups, which were recorded for transcription, the researcher used a list of interview questions to guide discussion about why the students chose to participate in the program, what programs they participated in the past, what they learned from the program (perceived outcomes), and recommendations for improvement (Emerson, Fretz, & Shaw, 2011). Portable recording technology was used to record the student focus group sessions. Immediately following the sessions, the files were uploaded onto a computer and securely housed as a digital file, ready for transcription. Transcriptions from the focus groups were created using *Microsoft Word* software.

Teacher interviews. At the end of programming (weeks 9 and 10), semi-structured interviews were conducted with 29 teachers in the STEM (n= 13) and Non-STEM (n=16) groups (Merriam & Tisdell, 2015). OST program teachers included classroom teachers at the school in addition to community partners from the local health department, museums, and community organizations. Some programs (like running club, sewing, and tree school) had more than one teacher. In these cases, both teachers were interviewed. Teacher interviews included questions about student learning and growth over the course of the program, the types of activities implemented throughout the program to meet the program goals, and how students' new knowledge and skills transferred into other areas of their lives. The interviews, which lasted approximately 30 to 45 minutes per teacher were recorded on a portable recording device, transcribed, and analyzed for trends and themes.

Program observations. Before programming began, each teacher in the STEM and non-STEM groups provided a hard copy list of program goals, session plans, and objectives for their program. Three observations of every program were conducted by the researcher during weeks 3, 6, and 9 to note the types of activities incorporated in the program and the level of fidelity to (or divergence from) the plans throughout the semester. Two programs (Origami and 1st -3rd Coding and Robotics) only received two observations during weeks 3 and 6 due to time constraints and cancelled school due to weather. Observation data was helpful in revealing what types of activities the students were participating in during OST programs, as well as the level of student participation in each STEM program. Additionally, they helped to triangulate the outcomes expressed by students during their focus group session. All the OST programs were observed for the aforementioned elements. The researcher adopted a participant observer role for the observations (Yin, 2014). Observations were approximately fifteen to twenty minutes. Notes were recorded on an observation record sheet during the program sessions and were subsequently coded using a start list of provisional codes for analysis (Miles, Huberman, & Saldana, 2014).

Field notebook. A field notebook housed the researcher's notes taken after each focus group, interview, and observation. Jottings of informal thoughts and connections made throughout the data collection and analysis process were included in the field notebook (Emerson et al., 2011). The information recorded in the field notebook was helpful, not only for data collection purposes, but also for generating a synthesis of findings and triangulating the various sources of data collected throughout the duration of the study.

Analysis

The qualitative nature of this research contributed to a robust amount of data. Organization of that data was critical for accurate analysis (Miles et al., 2014). The transcriptions from the interviews, parent and student focus groups, and observations were read several times so that the researcher was fully immersed in the data. Then each data source was analyzed and coded using a start list of provisional codes. They were subsequently analyzed using Dedoose qualitative data analysis package for topic trends and themes. A second layer of coding analysis occurred by creating and analyzing code counts, contact summary sheets, and qualitative data matrices. These were helpful in revealing overarching themes within and among all the interviews, observations, and focus groups conducted in the study. Finally, a third level of selective coding analysis was used to develop the narrative regarding the pertinent findings about student learning and outcomes that emerged throughout the data.

All sources of data were triangulated throughout the study to ensure study credibility. Member checks were conducted for all interviews. Additionally, to ensure dependability, peer audits took place at multiple points throughout data collection, analysis, and reporting phases. Finally, a meticulous chain of evidence was documented in order to verify the objectivity of the data and subsequent findings. This chain of evidence included a documented list of meetings and interactions related to the study.

Findings and Discussion

Upon analyzing the focus group, interview, and observation data, nine of the following code groups emerged: 21st century skills, 21st century themes, Non-STEM program specific codes, STEM program specific codes, STEM attitudes and learning, social emotional skills, student actions and observations, teacher actions and observations, and parent actions and observations. The codes that related most to perceived outcomes were 21st century skills and themes and STEM attitudes and learning.

Student Perceptions about STEM Attitudes

Students (pseudonyms used) who participated in STEM programs reported a shift in perceptions about STEM accessibility, the types of activities that qualify as STEM, and overall affect toward STEM. To illustrate the shift in perception of STEM accessibility, Emily, a fourth grade student in Tree School reported:

> I changed my way of thinking about STEM because I used to think STEM was just this over complicated, way-too-hard thing that I was never going to be able to do. But then when I'm going to after school programs, they kind of make it more simpler and then I can do it.

Younger students did not seem to have such a firm grasp on STEM components as instructional foci, rather, they simply knew that they enjoyed the activities that they were able to do during program time. In the focus groups with first through third grade students, there were three occasions during which students in coding and robotics clubs recognized that they enjoyed what they were doing in after school programs but did not make a connection that their work was classified as STEM.

> Jaekwon (student): I like coding and robotics more than STEM
>
> Researcher: You like coding and robotics? Did you know that coding and robotics *is* STEM?
>
> Jaekwon: It is?

Though the lesson plans for coding and robotics reflected a strong emphasis (see Figure 1.1) on technology use and the teacher mentioned her use of STEM in the classroom, it was clear that this young student had not yet conceptualized the meaning of STEM or connected it to program activities.

Figure 1.1.

OST Lesson plan for Coding club

SMART (Specific, Measurable, Attainable, Relevant, and Time-Oriented) Goals for the Program:

1. Students will have a safe place for creativity.
2. Students will be introduced to world + opportunities coding provides
3. Students will sharpen problem solving skills
4. Students will give + receive feedback.
5. Students will learn a variety of coding programs + tools.

Are you using a pre-developed curriculum for the program? (YES) NO

If yes, what curriculum are you using? Scratch

Overview plan for the program:

Session	Activity	Link to Standards (OAS, P21, or NGSS)
Week 1 Intro	Introduce scratch, students create on ipads	P21-creativity 1+7
Week 2 Exploring	Program to dance, 10 Block challenge	4-PS4-3
Week 3 Exploring	All about me project, students present	P21-critical thinking
Week 4 Animations	Build a band, It's alive	P21-creativity 1,2,3
Week 5 Animations	Debug It Challenge, Create music video	3-5-ETS1-2
Week 6 Stories	Create characters + conversations	P21-creativity
Week 7 Stories	Create scenes, play Pass It On	3-5-ETS1-1
Week 8 Games	Create dream game list, Create starter games	P21-Creativity 1-4
Week 9 Games	Game Extensions / Interactions	P21-critical thinking
Week 10	Presentation Day!	
Week 11		

What new skills will children acquire during your program?

simple coding, problem solving, communication

Students who *did* have a firm conception of STEM and its facets were able to discuss the diverse ways that they explored STEM concepts. In one exchange, a fifth grader named Stephanie exclaimed, “I love getting to do challenges!” She explained that even though challenges are sometimes difficult to solve, the joy is in “figuring out how to make [something] work.” In this case, she was referring to developing code to carry out desired functions in a computer game she was designing.

Overall, students reported positive attitudes about all four facets of STEM at the end of programs. Multiple students in Chemistry explained that their favorite parts of their program were creating chemical reactions, slime, and experimenting with chemicals like baking soda and vinegar. Jaylen, a second grader, revealed a change in his perception of confidence related to his experiences in Chemistry: “at first I didn’t know how to make nothing. Now that I’m in Chemistry, I know how to make like mostly everything.” Similarly, students reported positive attitudes in the area of technology with coding and robotics. Many of the 1st through 3rd grade students reported that their favorite activities were using iPads to create codes or to control a small robot in the classroom. The frustration was evident during an observation when one student emphatically explained “I really want to code this one robot that we have but he’s too complicated. We’ve tried to program him and we can’t get him to work!”

When students spoke about engineering and building tasks, they consistently referred to group activities and working with peers to build a house, robot, or other construction. The joy in the process of learning with others was apparent. Karly, a third grade student, explained that she got to work with “someone who is not in [her] class” to construct a weatherproof house. She described how she and the other student became friends and that even though they are not in the same grade or class, she looked forward to working with her during program time. The students also reported positive shifts in attitude toward mathematics. Francisco, a first-grade student explained, “I didn’t like to do math whenever we started [programs] and now we are doing it and I like it… Math is my favorite because I like learning about numbers and skip counting.”

Overall, students reported positive shifts in STEM related attitudes by the end of programming. Specifically, students discovered that STEM is accessible, it can include a variety of activities, and is enjoyable because of both STEM focused tasks and the collaborative nature of the work. These findings align with Karp and Maloney’s (2013) findings from a study on robotics programs. The researchers found that students’ (specifically girls') confidence levels and attitudes toward the scientific method increased and became more positive with repeated exposures to the robotics content. In this case, students' views of STEM as a construct and their capacities to engage with it developed over the course of the programs.

Student Perceptions about 21st Century Skills

Among the 21st century skills, learning and innovation skills were most commonly referenced by students in STEM programs. Learning and Innovation skills include creativity, critical thinking, communication, and collaboration (Battelle for Kids, 2019). The table below includes excerpts from STEM student focus groups that highlight student growth and learning in these areas.

Table 1.2

Student Perceptions of 21st Century Skills: Learning and Innovation Outcomes

21st Century Skill	Program	Source	Quote
Learning and Innovation Skills	Coding (4th-5th)	4th- boy, *Marlon*	Whenever I create code, it's like by using blocks in Minecraft. I'm just trying to fix a bug error from Minecraft. So it makes it more fun. I learned how to troubleshoot.
Creativity	Engineering with Connect Blocks	1st- boy, *Sebastian*	I also like to [build with connect blocks] so I can be like so creative. And my mind gets so creative and you can just [build] even bigger and it's like science.
Critical thinking	Tree School	4th- girl, *Macie*	[Being in my program] helped me learn how to solve problems. I used to plant a lot of trees and stuff and they kept dying and I had no idea why. So it is teaching me how to not make that mistake again.

21st Century Skill	Program	Source	Quote
Communication	City Engineering	Observation Notes	All students were working on building bridges. A few decided to work parallel to one another and complete their bridges together, discussing parts of the bridge and getting ideas from one another.
Collaboration	Coding (1st-3rd)	3rd- girl, *Alison*	We use teamwork and sometimes the teacher puts us in a group of three or four. We have a lot of fun working together.

Students perceived growth in the 21st century skill area of learning and innovation (specifically creativity, critical thinking, communication, and collaboration). These skills emerged from experiences in which students had the freedom to work together and the autonomy to make decisions about how to solve problems. Observed program activities that encouraged autonomy and problem solving included problem posing, group explorations, experiments, challenges, and open-ended questions (Dass, 2015). Alismail and McGuire (2015) identify problem-based learning and cooperative learning as instructional approaches that most effectively support the development of 21st century skills. STEM OST program lesson plans incorporated these instructional approaches and many of them were observed (see Coding club lesson plan example in Figure 1.1).

Parent, Teacher, and Student Perceptions of Student Outcomes

Each of the three groups- parents, students, and teachers- emphasized different outcomes from student participation in OST programs. Parents emphasized students' development of new interests while teachers emphasized students' development of social emotional and process-based skills. Students focused heavily on the relational aspects of OST programs, explaining that the most important outcomes were developing friendships and having free time to play and build. All groups mentioned the value of small class sizes, interest-based curriculum, and the value of multi-age groupings

Parent perspectives: Exposure to new interests. Each of the four parent focus groups (both STEM and Non-STEM) began with the question "Why did you enroll your child in OST programs?" In an almost predictable fashion, parents shared that it was important for them to connect their children with opportunities to cultivate new interests. One mother, Diana, explained that if her daughter did not have after school programs, she would come home and want to "play games on her tablet" for the entire night. She explained that her daughter, who was enrolled in Chemistry, had the opportunity to learn new concepts alongside her friends. This learning, she hoped, would translate into a new interest that she could pursue into middle and high school.

Similarly, Jaime, a father whose son was enrolled in Coding and Robotics, explained that his son cultivated not only new knowledge and interest, but also a new ability related to computer and technology skills. He reported:

> [My son] really likes to tell me about coding and how to take computers apart. He helps me at home on the computer. He also really wants to take everything technological apart and see what's inside.

Parents of students who experienced disengagement from school shared that their children developed a sense of belonging and newfound excitement related to school. Sharing about her 3rd grade daughter's school experience and involvement in STEM club, Carla explained:

> Because the subjects that she is in during school aren't her strengths, she feels isolated, but because she found other kids that are interested in the same thing, she now has a sense of belonging and she feels like she is a part of the group. So, she's able to relate better to others.

In this case, it was the relationships formed with her program teacher and peers during OST that made a difference in the student's level of engagement during the regular school day. Another mother, Denise, made a similar assertion about her 5th grade son who was enrolled in robotics:

> My son doesn't enjoy or have an interest in like the regular schoolwork, but through afterschool programs, he's been able to kind of hone the skills that he likes… interests that he didn't realize that he had. So now he is trying and doing more during the school day and taking more interest in reading and math because he wants to go back and take that to his afterschool program- the skills that he has found and is interested in.

This powerful insight suggests that the interests and skills that students cultivate during OST programs have powerful implications for student engagement during the school day. This aligns with the expressed goals for community schools outlined by the Partnership for the Future of Learning (2018). Expanded and enriched learning times (OST programs) should support the interests of students as well as their academics, artistic skills, and physical activities because there is a range of topics covered. This transfers to engagement and in-school outcomes (Maier et al., 2017).

Teacher perspectives: Social emotional and process skills. STEM teachers mentioned the development of a variety of social emotional skills 49 times during interviews. These social skills included confidence (12 mentions), patience (9 mentions), friendliness (8 mentions), and respect (7 mentions), just to name a few. Related to confidence, the phrase "coming out of their shell" was mentioned seven different times during teacher interviews about students' outcomes from participation in OST programs. This phrase captured the essence of the confidence that teachers perceived that their students had developed throughout the semester. In one interview, Magda the robotics teacher explained, "It's amazing how they come out of their shell and they find- each one of them- find a place to be. To be a part of the team." This sense of belonging appeared to be a precipitating force for the development of both confidence and, more broadly, social emotional skills.

Teachers also emphasized that the mechanism for this growth in social skills was the fact that OST programs were so different from the regular school day. With fewer students (maximum of 15 in most clubs), interest-based curriculum, and more flexibility, OST programs provided a space and time for students to learn through exploration, discovery, and experimentation with more teacher attention. Shaleah, another robotics program teacher and a 2nd grade teacher during the school day, made the following distinction between the regular school day and OST programs:

> I witnessed the growth in the students because it's such a different experience than what they do during the [school] day. It's just very open and inquisitive and discovery based. It is full of opportunities for them to grow. And I love it and we saw it throughout the program…Students learned because it wasn't required like school is required. [School] is something that they feel that they *have* to do and so this afterschool program was something they feel that they *get* to do…. It's not

> controlled. We get to say, 'Oh, you're interested in this? Well, let's go figure it out!' And it's individualized attention.

With large class sizes, pressures of standardized testing, and inflexible structures during the regular school day, many public school teachers often feel pressures associated with their work (Grissom, Kalogrides, & Loeb, 2017). At STEM Academy, teachers explained that OST programs provided a welcome reprieve from such pressures, as well as an opportunity for more relaxed and flexible teaching and learning to occur. Teachers shared that their time in OST programs felt like time where they could teach a student at his or her pace without the breathless feeling of having to move on to the next lesson in the curriculum due to time constraints and assessments. It could be argued that the authentic, relaxed, and student-centered OST environment is what classrooms *should* look and feel like.

In addition to sharing their insights about student outcomes, teachers openly shared the transformative personal impact of teaching OST programs. Just as students cultivated new skills, teachers shared that they developed instructional skills and adopted more effective ways of promoting student learning. According to Enid, the STEM club teacher who worked with students as they built miniature weatherproof houses:

> They taught me patience because there were times when I really wanted to step in and [say] 'here, I'll do it and I can show you what to do next time'. It was very good for me because I had to remember that this is their time to learn and they have to experiment. If I just show them how to do it, then they're not exploring on their own. I learned that groups will form naturally. I originally thought everybody would build their own structure…it was really awesome to watch this

> group come together. None of them play together [during the school day]. None of them are in the same class and it just was so amazing to watch how they just kind of gravitated towards each other and then suddenly you've got this amazing structure.

One final finding associated with STEM OST program teachers was the high frequency that critical thinking and problem-solving skills were mentioned (34 and 33 mentions respectively). These skills fall under the learning and innovation 21st century skills (Battelle for Kids, 2019) and help students to think in divergent and creative ways about obstacles that they encounter. Stephen, a fifth grade and OST Chess and Computers teacher explained:

> Problem solving- that's huge. Whenever they're coding, they have scenarios where they're given directions and resources on the side. But they aren't told how to use [the resources]. They are trained how to use them but are not told what specifically to do in that scenario. They are supposed to use the knowledge that they've gained to put pieces together and make it happen.

The teachers' accounts of learning in OST programs revealed that learning is not limited to content. Rather, the social skills and process skills developed throughout the learning activities in STEM programs granted students the abilities to learn information from a variety of disciplines.

Student perspectives: Peer relationships. Students communicated that the most important outcome of OST programs was the formation of relationships with their peers. The topics of teamwork and collaboration were among the most commonly mentioned during student focus groups. Students explained that they especially valued time in *free* *play* or *free build* with friends in their OST programs. It is important to note that students in OST programs came from different classes and different grade levels (1st through 3rd and 4th through 5th), giving students opportunities to get to know peers from other classes and grade levels. Additionally, students were able to share time and space with others who had similar interests and enjoyed the same types of activities related to the program. STEM activities were often open-ended and as Jeremy, a fourth grader in tree school mentioned:

> [Tree school] helps me work as a team because we do a lot of building and working together to solve problems and think about trees and what we can do to help trees that we've kind of just had to mend each other together and help each other out all the time.

Similarly, Yaretzi, a 3rd grader in robotics commented, "when we are programming a robot, we have to talk to them [the team] and figure something out- figure out how something is going to go."

Group activities like programming a robot or problem solving about tree placement on the school grounds helped to facilitate communication and the social skills necessary to collaboratively problem solve (part of the learning and innovation 21st century skills). Interestingly, in Ahonen and Kinnunen's (2014) study on children's prioritization of the importance of 21st century skills, social skills (in addition to information skills) was one of the highest-ranking skills identified by middle school students. The findings from this study support Ahonen and Kinnunen's (2014) findings. The essence of this finding is captured in a quote from Patrice, a 5th grader in Tree

School, “Being together so often helps. And if we were together more often, I bet we would be even better together.”

Context matters. During focus groups and interviews, each participant group mentioned the value of having small class sizes, enrollment based on student interest, and the multi-age nature of the programs. The context of OSTs, including the environment, number and configuration of students, and program content contributed to the students' capacity to learn, the quality of the interactions, and the teachers' capacity to facilitate STEM supportive activities (Allen et al., 2017; McClure et al, 2017). This finding has implications not just for OST programs, but instruction in all school settings. In the words of Shar, a mother of 2nd grader in Engineering with Connect Blocks club:

> It's not so many people or so many kids with one instructor, you know, it's more hands-on and like one-on-one also. So, you're kind of giving them a little bit more attention. You know, to concentrate on what they're doing.

The one-on-one attention and hands-on nature of learning made a difference in the experiences of students in this case study. Research conducted by Sahin, Ayar, and Adiguzel (2014) indicates that the qualities of being *hands on* and *minds on* are important precursors for learning and skill development in STEM programs.

The Benefits of OST Programs

Parents, students, and teachers in this study perceived unique outcomes from participation in OST programs. Students' conceptions and operational definitions of STEM evolved as they engaged in diverse experiences in their programs. Their attitudes about STEM were largely positive at the end of the study and all students who participated in focus groups reported that they would be interested in enrolling in a

STEM program again. Students reported that their 21st century learning and innovation skills developed as they worked collaboratively to problem solve alongside their peers. The collaborative nature and small group dynamic promoted relationship development, which was the most salient student-reported outcome.

For parents, the cultivation of new interests and opportunities to explore them were the most valuable aspects of their child's participation in STEM OST programs. Parents described that once students enrolled in the programs and their interests were piqued by the various STEM topics and activities explored in the clubs, their sense of engagement in school deepened. This engagement transferred over into the regular school day and students reported to their parents that they were eager to go to school because of after school programs. Importantly, the shared nature of these experiences among peers encouraged the growth of a sense of belonging, which further increased engagement and joy of learning sparked during STEM OST program sessions.

Interestingly, teachers highlighted the value of OST programs in supporting children's social emotional and process skills related to STEM. There was a recognition that though STEM content was important and was the focus of the activities during programming, the collaborative nature of learning promoted skills that could transfer to the regular school day and the comprehension of a variety of learning areas. These skills included learning and innovation skills (creativity, critical thinking, collaboration, and communication), as well as social emotional skills like confidence, patience, friendliness, and respect. These prosocial skills, teachers explained, help students navigate a wide variety of challenges and subject matter that students encounter during the typical school day and beyond.

Limitations

This case study provides evidence for the value of STEM OST programs in supporting 21st century skills, positive STEM attitudes, and a variety of social and learning dispositions that are conducive to critical thought and knowledge construction. However, it is important to acknowledge the existent limitations in the study. The first limitation for this study was the short-term nature of the intervention. Ten weeks of OST programs is a short timespan to promote significant behavioral change for students. However, the focus groups and interviews revealed that changes *did* occur, and those changes should not be minimized. The second limitation was that well-established positive STEM attitudes were already existent schoolwide at STEM Academy. With a robust offering of STEM courses during the regular school day, many students- even those not in OST programs- were afforded regular exposure to STEM instruction. They had time to cultivate interests during the regular school day. Though this means that student interest to participate in programs may be sparked during either the regular school day, it also means that it would be nearly impossible to attribute all shifts in STEM attitudes solely to STEM OST program participation. STEM programs are one of a few ways that students cultivate new interests.

Conclusion

STEM OST programs provide students with opportunities to engage in experiences that supplement and extend learning that happens during the regular school day (Maier et al, 2017). For students in community schools, this extension and enrichment is an invaluable opportunity to cultivate skills that will prepare them for learning tasks far beyond OST programs. 21st century skills are not content-specific, rather, they support learning in all domains (Alismail & McGuire, 2015). For this reason, fostering the development of these skills is a crucial step and can maximize later school success. However, these skills alone are not sufficient for supporting this success. Students' attitudes toward content, which are related to engagement, promote school retention and the cultivation of interests that sustain them through many years of schooling (Maier et al., 2017). STEM OST programs provide opportunities for interests and positive attitudes to grow. With strong evidence that entry into the *STEM pipeline* is crucial for continued STEM interest through elementary, middle, and secondary school, supporting STEM interests early helps students to identify themselves as individuals who participate in and enjoy STEM (Lyon, Jafri, & St. Louis, 2012).

The implications of these findings are that the processes and structures in place during STEM OST programs are conducive to learning, skill development, and relationship formation- all factors of student engagement (Partnership for Future Learning, 2018). For this reason, OST programs and their characteristics should receive more attention in terms of their context, structure, and design. Class sizes are limited to protect the relationships among students and teachers. To effectively facilitate group work that allows for conversation and freedom to explore, this cap of approximately 15 students is crucial. Additionally, the multi-age nature of programs supports peer learning. Older students learn from younger students and vice versa. Finally, designing curriculum around student interest and responding to students' questions and expressions are effective ways to promote student learning (Peace, Polka, & Mete, 2017). OST programs provide a space where the convergence of student engagement, positive learning attitudes, relationship development, and sense of belonging occurs. Evaluating the OST program space more closely with the intent to transfer the structures (class size, student-centered curriculum, and multi-age groupings) to the regular school day is worth consideration. For schools that simply cannot make structural changes, OST programs provide the freedom and space to support and enrich student learning (Maier et al., 2017). Though not all schools are community schools, providing OST programs is something that all schools, in collaboration with their communities, can develop the capacity to provide.

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MANUSCRIPT II

Evaluating Out-of-School Time (OST) Program Outcomes Associated with 21st Century Skills

This manuscript is prepared for submission to the peer-reviewed journal, *Afterschool Matters,* and is the second of three manuscripts prepared for a journal-ready doctoral dissertation.

Abstract

One challenge associated with the provision of out-of-school time (OST) programs is identifying a holistic method of evaluating program outcomes that incorporates the voices and perspectives of all program participants. This case study set in a community school with established OST programs sought to identify students', parents', and teachers' perceived outcomes from student participation in science, technology, engineering, and mathematics (STEM) and Non-STEM OST programs. Parent and student focus groups, teacher interviews, program lesson plans and observations served as key data sources for the qualitative study, which focused on OST programs and outcomes related to 21st century skill development. Students, parents, and teachers perceived different program outcomes including relationship development, content learning, and process skills, respectively. STEM programs were associated with information, communication, and technology *skills*, while Non-STEM programs were found to support information *literacy.* Both STEM and Non-STEM programs were associated with the development of social emotional skills and learning and innovation 21st century skills. The Framework for 21st century learning served as the theoretical framework for the study. Implications of the findings and possible applications of the qualitative methodology are discussed.

Keywords: out-of-school time (OST) programs, 21st century skills, STEM, community schools

Evaluating Out-of-School Time (OST) Program Outcomes Associated with 21st Century Skills

Supporting students as they become 21st century citizens in the age of technology presents an unprecedented set of challenges for educators. The most prominent of these challenges is ensuring that all students have equitable access to high quality academic programs, including a variety of science, technology, engineering, and mathematics (STEM) opportunities that promote the development of 21st century skills (National Research Council, 2011; Sahin, Ayar, & Adiguzel, 2014). Exposure to such curricular and extra-curricular resources helps to develop these skills and inspires students to start thinking about career possibilities. Out-of-school time (OST) programs have gained recognition as valuable approaches to extending student learning while also building interest and engagement (Beckett et al., 2009). The Community Schools strategy, which incorporates OST programs as a core instructional component, promotes equitable student access to such opportunities (Maier, Daniel, Oakes, & Lam, 2017).

Problem and Research Questions

Program evaluation is a critical component of OST planning, success, and expansion; however, OST programs are characteristically different than in school programs and require different forms of evaluation (Allen et al., 2016; Murchison, Browhawn, Fancsali, Beesley, & Stafford, 2019). In community schools, the voices of students, families, staff members, and those in the surrounding community are the most highly valued perspectives related to program success. Consequently, interviews and focus groups are effective approaches to promoting community development while also capturing program outcomes, challenges, and strengths. This study seeks to fill gaps in literature related to student outcomes and 21st century skills associated with participation in OST programs. Additionally, the study includes a replicable methodology for providing a community-centered program evaluation that can be implemented in a variety of settings.

The study was conducted in a Title I community school with extensive STEM and Non-STEM program offerings and was guided by the following questions:

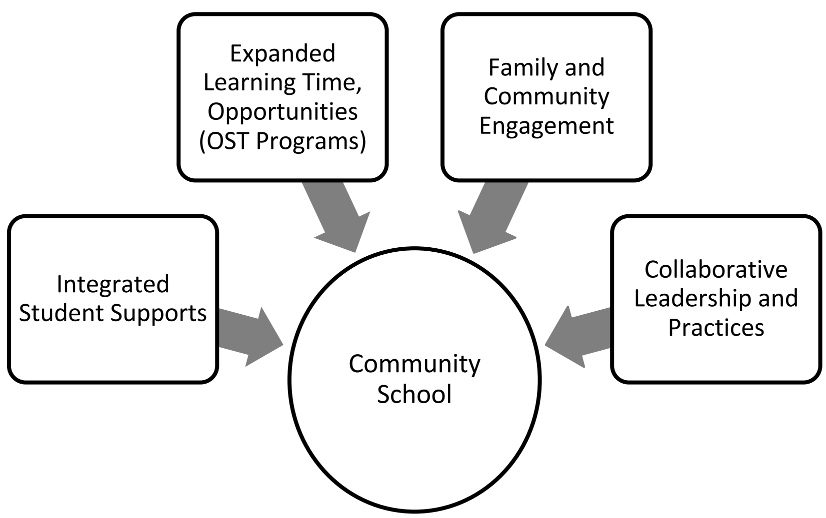
1. What outcomes do students, parents, and teachers perceive from student participation in OST programs?
2. What influence do STEM and Non-STEM programs have on students' development of 21st century skills?

Background

Community School Framework

Figure 2.1.

Community School Framework: 4 Pillars of Community Schools



Note. Figure adapted from Partnership of Future Learning (2018).

Community schools seek to build strong schools and neighborhood communities by meeting the needs of students and families and facilitating connections with community partners (Partnership for the Future of Learning, 2018). These connections are determined by the four pillars of community schools- integrated student supports, expanded learning time and opportunities, family and community engagement, and collaborative leadership and practices (Maier et al., 2017; see Figure 2.1). Community schools exist not only as a physical location for neighborhood and school stakeholders to come together, but also as a set of partnerships that promote student and family wellbeing (Jacobsen, Hodges, & Blank, 2011). Full-service community schools partner with local agencies to coordinate comprehensive services for families. These agencies include medical clinics, health departments, behavioral health organizations, afterschool program providers, businesses, and any other community group interested in partnering with the school (Maier et al., 2017).

Out-of-School-Time Programs

OST programs provide students with an enriching and safe place to go before and after school. During program time, students can collaborate with peers in team settings and engage in well-structured activities that extend their academic and social emotional learning (Beckett et al., 2009; Dryfoos, Quinn, & Barkin, 2005). This time grants both teachers and students a reprieve from the pace of the regular school day that is often filled with pressures associated with standardized testing, pacing calendars, and strict adherence to curricula (Grissom, Kalogrides, & Loeb, 2017; Maier et al., 2017). Unique features of OST programs that make them different from the regular school day include: (Maier et al., 2017; Partnership for the Future of Learning, 2018):

1. Students *choose* to participate in the programs with peers who share similar interests. Enrollment in programs is optional and based on student interest.
2. Class sizes are generally smaller, between 10-15 students, to afford more teacher-student support.
3. OST programs are less structured, and teachers can create and pace their lessons based on students' interests and needs.
4. Program topics can include a variety of different content areas including both academic concepts and non-academic skills (i.e. Chemistry or Running club).

These characteristics allow OST programs to be free from many of the constraints that make the regular school day feel taxing, stressful, and laborious (Becket et al., 2009; Grissom, Kalogrides, & Loeb, 2017). OST programs give students access to information and activities that they crave, while simultaneously allowing teachers the instructional autonomy to teach in creative and engaging ways (Maier et al., 2017).

Key Literature about STEM and Non-STEM OST Programs

OST STEM instruction. Recognizing that OST programs provide a unique space for student learning and the development of 21st century skills through STEM instruction, The National Research Council (2015) developed three criteria for implementing productive OST STEM programs. These criteria call for programs to be engaging, responsive, and connective. Engaging activities include tasks like collaborative problem solving, experiential activities, and inquiry-based methods that challenge students to work with their peers toward the completion of a goal or objective. Collaborative learning naturally yields intellectual engagement as well as social skill development. The social nature of these activities enables teachers to get to know their students and facilitate learning opportunities that are considerate of students' interests, needs, cultures and experiences. Students are empowered to create knowledge that they perceive as valuable and applicable in many different contexts.

Acknowledging that students connect new information to their past experiences and current knowledge, the National Research Council (2015) uses the STEM ecosystem model to explain STEM learning during both in-school and OST programs. The student is at the center of the STEM ecosystem and is influenced by relationships with others and the settings within which the child lives and goes to school. Just as the environment influences the student, the student's knowledge, interests, and personality affect others who share the space (McClure, 2017). A student's participation in a supportive STEM OST context encourages her interests and satisfies her curiosities over time. Starting in the earliest years of school, the student's interests expand to include other more sophisticated concepts and new pursuits. This evolution in interests contributes to the STEM ecosystem and the experiences of the teacher and peers in the program, as well as the school. Consequently, OST programs help the school's STEM ecosystem thrive and expand (National Research Council, 2015).

Non-STEM OST programs and social emotional skills. Not all OST programs must be academically focused in order to support positive student outcomes. Research conducted by Fifolt, Morgan, and Burgess (2018) revealed that students who participated in an experience-based urban farming OST program reported increased levels of responsibility and accountability, development of peer-to-peer and student-to-instructor relationships, higher levels of self-efficacy, and life skills. All these skills can be classified as 21st century skills (Battelle for Kids, 2019). Through participation in the program, which was not overtly an academic program but naturally incorporated academic concepts like physical science, students developed new learning and life skills. Similarly, Hurd and Deutsch (2017) reported that OST programs with a social emotional learning (SEL) focus like 4-H, Boys and Girls Clubs, and recreational sports promoted student interests, talents, confidence, feelings of self-efficacy, and opportunities for relationship formation. These positive OST experiences play an essential role in increasing engagement in school (Maier et al., 2017).

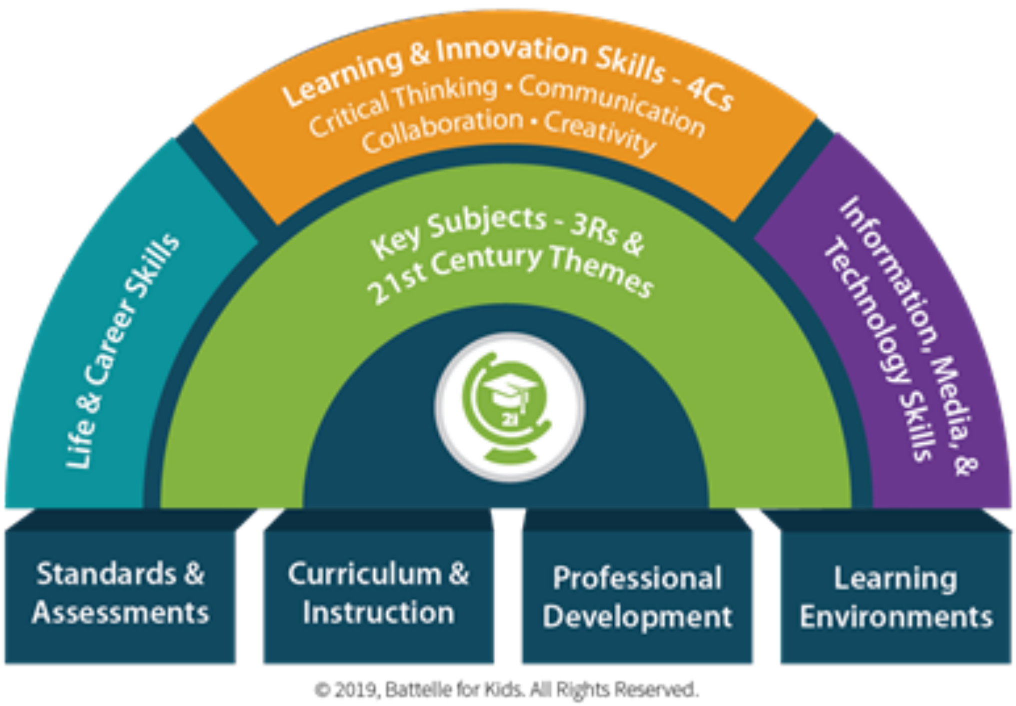
A longitudinal study of student engagement in OST programs reveals that students who participate in programs over time experience increases in academic and social skills as well as overall school engagement (Grogan, Henrich, & Malikina, 2014). Researchers suggest that during OST times, students are intrinsically motivated to learn, they enjoy the learning process, and they feel a sense of belonging to a group. Feelings about OST time can carry over into the school day, simply because the curricular and extracurricular experiences occur in the same space. Also, students tend to associate positive OST experiences with school in general because they *feel* like a part of the school day (albeit an extension). Furthermore, social skills like empathy, teamwork, and self-regulation, which are reinforced during program time, can translate into the student's regular school experience. The evidence of increased school engagement as a result of OST programs reveals the value of providing well-structured academic and non-academic OST learning opportunities for students.

Framework for 21st Century Learning: 21st Century Skills

21st century skills are considered necessary for success in innovative 21st century professions (Battelle for Kids, 2019). They include dispositions and traits that promote learning in multiple disciplines like literacy, mathematics, arts, humanities, and science. In addition to these dispositions, there are 21st century themes, which include global awareness and financial, civic, health, and environmental literacy.

Figure 2.2.

Framework for 21st Century Learning



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The Framework for 21st Century Learning highlights three skill areas in particular: Life and career skills; learning and innovation skills; and information, media, and technology skills (see Figure 2.2 and Table 2.1). Within each of these skill areas are subskills and learning themes. Additionally, key areas of literacy like global awareness, civic literacy, and health education promote a well-rounded understanding of life in the modern world.

Instructional training and resources are the foundational mechanisms for promoting 21st century skills in the classroom.

Table 2.1

21st Century Subskills, Key Subjects, and Learning Themes

21st Century Skill or Theme	Subskills and Subthemes
Life and Career Skills	Flexibility and Adaptability Initiative and Self Direction Social and Cross-cultural skills Productivity and Accountability Leadership and Responsibility
Learning and Innovation Skills	Creativity and Innovation Critical Thinking and Problem Solving Communication Collaboration
Information, Media, and Technology Skills	Information Literacy Media Literacy ICT (Information, Communications, and Technology) Literacy
21st Century Themes	Global Awareness Financial, Economic, Business, and Entrepreneurial Literacy Civic Literacy Health Literacy Environmental Literacy

Note. Table adapted from Battelle for Kids (2019).

Methods

This qualitative case study examined the following two questions: 1) What outcomes do students, parents, and teachers perceive from student participation in OST programs? 2) What influence do STEM and Non-STEM programs have on students' development of 21st century skills? The study included student and parent focus groups, teacher interviews, program lesson plans, and observations as primary methods of evaluation to capture perceived program outcomes.

Sample and Setting

The study was conducted in a Midwest Title I community school where there were twenty-three, 8 to 10-week OST programs available to students during the fall semester of the 2018-2019 school year (see Table 2.2 for program offerings). The sample, a portion of the students in the school who participated in programs, included first through fifth grade students (n= 117), parents (n=24), and OST program teachers (n= 29). Program teachers included both full time teachers and paraprofessionals who worked at the school as well as teachers employed by the community partner programs.

Of the students in the study, 60 were in STEM programs (39 in 1st-3rd grade, 21 in 4th-5th grade) and 57 in Non-STEM programs (29 in 1st – 3rd grade and 28 in 4th-5th grade). During the enrollment process, all 117 students noted that they would like to participate in a STEM club. However, due to clubs reaching their capacity, some students were assigned to their second or third Non-STEM choices (which made up the Non-STEM group). Both STEM and Non-STEM groups expressed similar interests in STEM as evidenced by enrollment selections. Fifty-five percent of the students in the study were female (n=64). The STEM program student sample included 61.7% Latinx or Hispanic, 21.7% African American, 10% Caucasian, 5% Asian, and 1.7% American Indian students. The Non-STEM group of students was comprised of 52.6% Latinx or Hispanic, 21.1% African American, 17.5% Caucasian, 7% Asian, and 1.8% Pacific Islander students.

Table 2.2

OST Program Offerings

Program Name	Category	Grade	Sessions/ Week	Number of Students	Teacher Type
Connect Block Art (2 sections)	Non-STEM	1st-3rd	1	15	School
4-H, Farm Fun	Non-STEM	1st-3rd	1	15	Community
Readers Theater	Non-STEM	1st-3rd	2	13	School
Camp Fire Starflight	Non-STEM	1st-3rd	1	12	Community
Sewing	Non-STEM	4th-5th	1	8	School
Origami	Non-STEM	4th-5th	1	15	School
Choir and Instruments	Non-STEM	4th-5th	1	15	School
Gardening (2 sections)	Non-STEM	4th-5th	2	20	Community
Sports Club	Non-STEM	4th-5th	1	20	Community
Running Club	Non-STEM	4th-5th	1	18	School
Camp Fire Adventure	Non-STEM	4th-5th	1	12	Community
Song Writing and Dance	Non-STEM	4th-5th	1	15	Community
Soccer	Non-STEM	4th-5th	2	23	School
Engineering with Connect Blocks (2 sections)	STEM	1st-3rd	1	15	School
Art and STEM	STEM	1st-3rd	1	15	Community
Chemistry	STEM	1st-3rd	1	15	Community
STEM Club	STEM	1st-3rd	1	15	School
Coding and Robotics 1	STEM	1st-3rd	1	15	School
Coding and Robotics 2	STEM	4th-5th	1	14	School/Community
Robotics	STEM	4th-5th	2	10	School
City Engineering	STEM	4th-5th	1	10	Community
Chess and Computers	STEM	4th-5th	1	13	School
Tree School	STEM	4th-5th	1	14	School/Community

Data Sources and Procedures

It was of primary importance to capture perceptions of student outcomes in the most holistic way possible. To accomplish this task, four qualitative data sources were used to identify 21st century skills and specific student outcomes: program lesson plans, observations, focus groups (student and parent), and teacher interviews. Each data source provided important insights about the processes that promoted learning as well as student, teacher, and parent perceptions of learning. Notes about each of the four data sources were collected in a field notebook.

Lesson plans and observations

Lesson plans and program goals were collected prior to the start of the programs. To complete the plans, teachers recorded specific, measurable, attainable, relevant, and time-oriented (SMART) goals for their programs and listed curricular resources; included a week-by-week scope of program activities; and projected skills and outcomes associated with participation in the program. These program plans served as helpful guides during program observations. An average of three program observations, lasting 15- 20 minutes, were conducted during weeks 3, 6, and 9 of programming. The observations allowed the researcher to record student and teacher interactions, program activities, student/teacher actions and behaviors, and to see how the lesson plans aligned with actual instruction.

Focus Groups and Interviews

All parent and student focus groups were recorded for later transcription and analysis. A list of questions was used to guide the focus group conversation and ensure that all topics were covered during the focus group session. Parent and student focus group questions were written in parallel form in order to capture both students' and parents' perceptions about learning outcomes from OST participation (See Table 2.3).

Parent focus groups. Four parent focus groups were conducted during weeks 8 and 9 of programming. Parents were randomly selected and assigned to a focus group based on student age (1st through 3rd or 4th through 5th) and program content (STEM or

Non-STEM). Each parent focus group included 5 to 10 parents and lasted between 30 and 45 minutes directly after the end of OST programs on four different days.

Student focus groups. Seven student focus groups took place during weeks 8 and 9 of programming. Similar to the parent focus groups, eight students were randomly assigned to a focus group based on age and program content. Student focus groups took place just before the start of programs and lasted around 15 to 20 minutes.

Table 2.3

Parent and Student Focus Group Questions

Student and Parent Focus Group Questions
1. What did you like about the program? *(same question for students/parents)*
2. What did you dislike about the program? *(same question for students/parents)*
3. What was your *(your child's)* favorite activity in the program and why?
4. How did being a part of the program change the way you *(your child)* think about STEM?
5. What did you learn when you worked with a partner or in a group? *What social skills did your child develop while he or she participated in the program?*
6. What new knowledge have you *(has your child)* used in class, at home, or outside of school?
7. How has being in the program helped you *(your child)* learn how to solve problems?
8. How has being in the program helped you *(your child)* learn how to work in a team?
9. Would you like to learn more about the topic you learned about in your program? *Will you enroll your child in other similar programs in the future? Why/why not?*

Note. Questions were developed by the researcher; parent question changes are italicized.

Teacher interviews. All OST program teachers (29) were interviewed at the end of programming. Of the teachers interviewed, 13 taught STEM clubs and 16 taught Non-STEM clubs. The interviews were recorded and later transcribed for analysis. The interviews were semi-structured and interview questions were used to guide the conversation and ensure that each teacher covered relatively similar content related to their OST program (see Table 2.4).

Table 2.4

Program Teacher Interview Questions

Program Teacher Interview Questions
1. Why did you choose to teach the program? What was it about the content of the program that made you want to teach?
2. What did you learn while teaching your program?
3. What did you enjoy/not enjoy about teaching your program?
4. What were your students' favorite activity/ies this semester?
5. What was the most important thing that you taught your students/that your students learned in the program?
6. How did teaching this program change the way the students felt about STEM?
7. What social skills did the students develop in your program?
8. How does the content of your program relate to school or home?
9. How did your program promote problem solving and teamwork?
10. What other information would you like to share with me about your experience teaching STEM (or other programming) this semester?

Note: Questions were developed by the researcher.

Data Analysis

Once the data were collected and stored as secured audio files, they were transcribed and prepared for analysis. Before the first cycle coding, the researcher read through all the transcriptions in order to be fully immersed in the data. The first cycle, line-by-line coding with a starter list of 21st century and STEM codes, was carried out using Dedoose qualitative data analysis package (Bazeley, 2013). During the second cycle coding, the researcher looked for patterns and themes emerging across the data types. During the third and final stage of coding analysis, a narrative was formed to articulate the findings that emerged from the sources of data.

Findings and Discussion

Perceived Program Outcomes

In focus groups and interviews, each of the three groups- parents, students, and teachers- emphasized different outcomes from student participation in OST programs (both STEM and Non-STEM). Teachers emphasized students' development of social and emotional process-based skills, while parents focused more on students' content-specific learning and the cultivation of new interests. Students focused heavily on the relational aspects of OST programs, explaining that the most important outcomes were developing friendships and having time to freely play and build together. Lesson plans and observations illuminated the practices that most effectively supported these outcomes, which included intentional questioning, outdoor learning, free play, small group learning and peer support, and teacher presence and *circulation* to check in with individual students and small groups during learning time.

21st Century Skills and Themes Developed in STEM and Non-STEM Programs

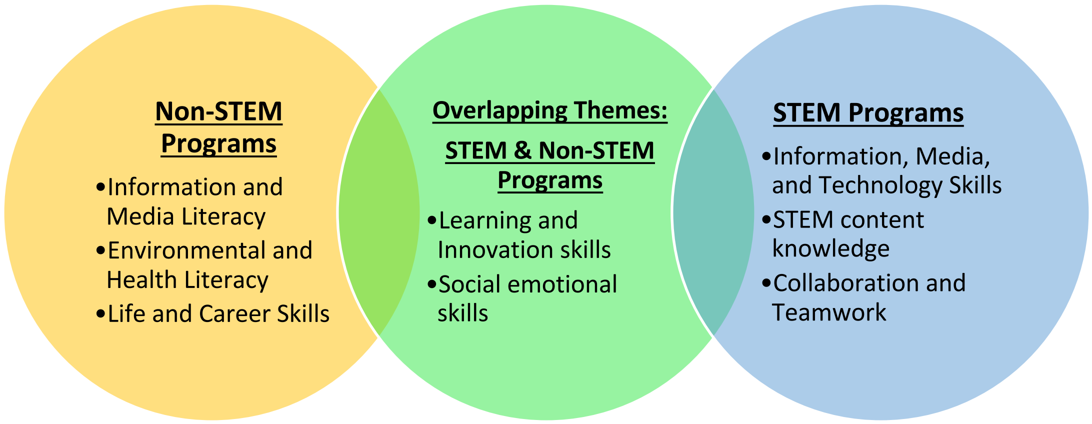
The data showed that specific 21st century themes were linked to STEM programs, Non-STEM programs, and OST program participation in general (See Figure 2.3). All participants, regardless of OST program, shared that involvement in programs promoted social emotional skills and Learning and Innovation 21st century skills. Learning and Innovation skills include creativity, critical thinking and problem solving, communication, and collaboration (Battelle for Kids, 2019). To illustrate this point, Macie (pseudonyms used), a fifth grade student in Tree school (STEM) reported,

> [Being in my program] helped me learn how to solve problems. I used to plant a lot of trees and stuff and they kept dying and I had no idea why. So it is teaching me how to not make that mistake again.

This quote demonstrates problem-solving skills that students in the club cultivated over time. Similarly, Maria, another fifth grade student in Sewing club (Non-STEM) reported, "If you are sewing and you are by yourself and you have a problem, you will continue to be stuck unless you ask someone to help you [solve the problem]." Even though both girls were in different programs, their responses revealed their learning about the collaborative nature of problem solving, an important learning and innovation skill.

Figure 2.3.

21st Century Themes Linked to STEM and Non-STEM programs



Literacy and life skills in Non-STEM programs. Non-STEM programs included a wide variety of activities and content areas. In clubs like soccer, sewing, and choir, students experienced programs with a non-academic focus. The most commonly mentioned 21st century outcome was literacy, which is defined as subject-specific knowledge that moves students toward an expert-level understanding of content (Battelle for Kids, 2019). More specifically, information, media, environmental, and health literacy were all identified as primary outcomes by participants. Thus, environmental literacy defined within the Tree School program context was a conceptual understanding of how plants and trees grow, what their needs are, what conditions are most optimal for their growth, etc.

Improved literacy in the areas of information (reading and understanding texts), media (music and art), environmental (plants and gardening), and health literacy (sports and movement) were identified as outcomes associated with student participation in Non-STEM programs. Life and career skills, the other outcome associated with Non-STEM programs, included flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility. Students had multiple opportunities to develop such skills as they played team sports (collaboration), wrote and edited songs (flexible thinking), and worked together to prepare for a choir performance (social skills and accountability). These findings align with the results in the Fifolt et al. (2018) study, which suggest that Non-STEM OST programs promote the development of a variety of life skills.

STEM knowledge, skills, and collaboration in STEM programs. Activities included in STEM programs were focused exclusively on science, technology, engineering, and mathematics. Compared to Non-STEM programs, STEM programs were naturally more limited in their scope. Data from focus groups and interviews revealed that these programs lent themselves to the development of information, media, and technology *skills*. While Non-STEM program outcomes focused on *literacy* (subject-specific knowledge), STEM programs focused on *skills*. Observations and lesson plans from STEM programs revealed that the primary activities included tasks like building models, coding computer commands, generating tree planting plans, or programming robots. These experiential, inquiry-based tasks aligned with the types of STEM activities suggested by the National Research Council (2015): They were student-focused and required both STEM literacy (content knowledge) and the skills to effectively apply the knowledge. Observation data revealed that students in STEM programs were often engaged in team-based tasks with the goal of collaboratively completing objectives.

OST program components and 21st century skills as outcomes. Four important OST components were revealed in the data: content knowledge, process skills, relationship development, and pedagogy and practice. Knowledge of all four components can be helpful in planning effective programs that support student growth and learning. Another helpful tool that can be used for program planning, implementation, and evaluation is the Framework for 21st century learning (Alismail & McGuire, 2015; Battelle for Kids, 2019). Since 21st century skills include dispositions that promote learning in a variety of subject areas (rather than domain-specific), they can effectively serve as indicators of success for OSTs that cover a wide range of subject and skill areas.

OST programs provide students with opportunities to explore non-academic interests, expand their understanding of academic content, and cultivate new talents (Maier et al., 2017). Recognizing that the regular school day presents a host of challenges associated with large class sizes and standardized tests and curriculum, OST programs have the capacity to provide learning time that is unencumbered by typical school constraints (Grissom, Kalogrides, & Loeb, 2017). In OST programs, students can pursue information that interests them from teachers who have autonomy to teach in creative ways (Beckett et al., 2009). Smaller group sizes allow for more meaningful interactions among peers and between teachers and students. Though OSTs tend to be less structured than the regular school day, this does not mean that they are free of accountability or evaluation. Rather than using test scores or grades collected during the school day to measure learning and growth from OST programs, using 21st century skills and student, parent, and teacher feedback as indicators of growth are a more appropriate and student-centric approach to gauging and reporting student outcomes associated with OST learning.

Limitations

The length of programs studied in this research serves as a limitation. Programs included in the study were only 10 weeks long. It could be argued that this limited amount of time spent in OST programs once or twice weekly may not have a lasting effect on students' concept and skill development. However, student and parent focus groups and teacher interviews revealed personal experiences that illustrated 21st century skill development, social emotional growth, and the acquisition of new learning. Additionally, it could also be argued that if nothing else, these limited exposures to concepts during the OST programs serve to spark interests that students can pursue in future semesters both in and out of school.

Conclusion

The implications of the findings in this study relate to instructional programs both in and out of school time. Regardless of program type, there is capacity for 21st century skill support during instructional programs. Leveraging instruction to support the development of literacy and skill-based learning, especially before and after school, serves students well in other areas of their lives and academic careers. Additionally, the methodology presented in this paper provides a helpful framework that can be replicated and scaled in other school settings interested in using the voices within the school community to help measure program success and outcomes.

To effectively prepare students to enter a society that values innovation and critical thought, innovative instructional strategies are required. OST programs provide an ideal learning environment for students to cultivate their own interests, learn how to work as a team, build relationships with their peers and teachers, and develop the skills needed for academic success both in school and beyond. For students who feel disengaged or disinterested in the typical school day experience, OST programs serve as vital connection points to school. Community schools pair these well-structured, extended learning times with family support in order to promote equity and overall student and family success. Looking at OST programs through a lens of equity and engagement will help to expand what is understood of innovative instructional practices. OST programs provide an effective and engaging way to prepare students to become 21st century citizens, ultimately the most important outcome of 21st century schools.

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MANUSCRIPT III

The Effects of STEM Out-of-School Time (OST) Programs on the Development of STEM Attitudes and 21st Century Skills of Community School Students

This manuscript is prepared for submission to the peer-reviewed journal, *Journal for Research in Science Teaching,* and is the third of three manuscripts prepared for a journal-ready doctoral dissertation.

Abstract

Out-of-school time (OST) programs provide unique opportunities for students to develop 21st century skills and interests in a variety of topics. With national emphasis on STEM competencies and careers increasing over time, more attention is being given to OST approaches that support STEM learning effectively. Community Schools, which include OST programs as fundamental components of their instructional strategy, seek to provide equitable access to high quality learning opportunities that promote student success. This mixed methods, quasi-experimental study, set in a Title I Community School in the Midwest, sought to identify and compare outcomes associated with participation in STEM and Non-STEM OST programs. A theory of change that supports the formation of positive STEM attitudes and 21st century skills was developed. Data sources included student surveys, parent and student focus groups, teacher interviews, and program observations. Students who participated in STEM OST programs demonstrated increase from pre to post test scores on a measure of STEM Identity and students who participated in Non-STEM OST programs demonstrated pre to post-test increase on a measure of 21st century skills. Qualitative data added nuance to the findings, revealing that each participant group perceived different program outcomes including learning and innovation 21st century skills (all participants), social and relational development with peers (students), cultivation of content knowledge and skills (parents), and development of social emotional skills (teachers).

Keywords: Out-of-school time (OST) programs, community schools, STEM, 21st century skills

The Effects of STEM Out-of-School Time (OST) Programs on the Development of STEM Attitudes and 21st Century Skills of Community School Students

Over the past few decades, science, technology, engineering, and mathematics (STEM) instruction in U.S. public schools has become an area of intense national focus (Thomasian, 2011). The causes for this fascination are two-fold: 1) in the technological age, STEM professionals innovate and help make the U.S. globally competitive, and 2) STEM professions are known for being stable and lucrative. Professionals in STEM fields earn higher wages than their Non-STEM professional counterparts (Fayer, Lacey, & Watson, 2017). The starting salary for STEM jobs is around 25% higher than Non-STEM professions and states with higher proportions of STEM jobs also boast higher overall salaries (Burning Glass, 2014; Fayer, Lacey, & Watson, 2017).

Theoretically, strong STEM instruction should produce students who are eager and ready to enter STEM professions. However, an interesting reality exists that U.S. students are trailing behind their peers in other nations on science and mathematics aptitude, ranking 25th and 39th respectively on the 2015 Program for International Student Assessment (PISA; OECD, 2016). Moreover, an analysis of the demographic makeup of workers in STEM professions reveals a lack of diversity in STEM fields. Minorities, especially Latinas and African American males, are starkly underrepresented in STEM fields (Wright, Ford, & Scott, 2017; Young, Young, & Ford, 2017). National statistics of STEM careers in 2011 revealed that 70% of jobs were held by Caucasians, 19% Asians, 5% Latinos, and 5% African Americans (Excelencia in Education, 2015; Landivar, 2013). Of all STEM professions, women hold a mere 24% while men hold 76%, reflecting a gender gap in the STEM career landscape (Beede et al., 2011).

Such a discrepancy may be attributed to lack of availability of high-quality STEM programming in schools highly attended by students of color (Krishnamurthi et al., 2014; Ladson-Billings & Tate, 2008). The U.S. Department of Education (2015) reports that many underperforming rural and urban schools do not have the capacity (i.e. lack of resources or instructors) to teach STEM courses that enhance students' understanding of a variety of STEM topics. Only about half of the high schools in the U.S. offer calculus and 63% offer physics courses. In these schools, there is limited availability of algebra, geometry, biology, and chemistry courses. There are not enough instructors to teach the courses in these schools, much less track and encourage students' trajectories through the challenging coursework. Equity concerns are serious issues associated with STEM instruction (Darling-Hammond, 1998; Ladson-Billings & Tate, 2008; Landivar, 2013), along with the quality of instructional delivery (McClure et al., 2017; National Research Council, 2011; U.S. Department of Education, 2015).

Methods associated with *traditional* schooling include rote learning, memorization of facts, scripted curricula, and de-contextualized instruction broken up by subject area (National Research Council, 2011). These approaches do not serve students who need skills like communication, critical thinking, and creativity in order to be successful in the 21st century workforce (Alismail & McGuire, 2015; Hall & Miro, 2016). To update such practices, it is important to consider areas in the field where the implementation of unconventional and innovative methods can effectively promote student growth and success. One such area exists outside of the school day entirely (Beckett et al., 2009; Bodilly & Beckett, 2005; Maier et al., 2017). Out-of-school time (OST) programs have become an increasingly popular approach to building student interest and extending students' STEM learning (Wilkerson & Haden, 2014). The Community Schools strategy, of which OST programs are a core component, seeks to promote equity and offer students a wide variety of extracurricular options (Roche, Institute for Educational Leadership, & Coalition for Community Schools, 2017; Maier et al., 2017). These programs promote school engagement, interests in STEM related topics, and *21st century skills*, which include collaboration and teamwork, creativity and imagination, critical thinking, and problem-solving skills (Alismail & McGuire, 2015; Battelle for Kids, 2019; Lyon, Jafri, & St. Louis, 2012; Popa & Ciascai, 2017).

Problem and Research Questions

OST programs have the capacity to promote equity of STEM access for all students, specifically those underrepresented in STEM fields (Partnership for the Future of Learning, 2018). Although there are a variety of research studies related to after school programs in general, there exists a paucity of research that addresses evaluation of student outcomes associated with STEM OST programs in well-resourced Community Schools (Afterschool Alliance, 2015; Durlak & Weissberg, 2007; Maier et al., 2017). Ensuring that OST programs effectively support students' learning and interest cultivation is important for program improvement and continuation (Murchison et al., 2019). However, identifying appropriate outcomes and quality evaluation tools can be challenging with students as young as first grade whose capacities for taking surveys can be variable depending on the child's development, mood, reading level, possible response-shift bias, etc. (Afterschool Alliance, 2015; Nakonezny & Rodgers, 2005; Wilkerson & Haden, 2014). This study sought to fill the gaps in research through the implementation of both qualitative and quantitative evaluation methods in order to gain a holistic understanding of students', teachers', and parents' perceptions of outcomes related to participation in OST programming in a fully functioning, Title 1 Community School. Special focus was placed on students' STEM attitudes and 21st century skills. The guiding questions for the study included:

1. What effect do STEM related OST programs have on students' attitudes toward STEM learning?
2. What effect do STEM related OST programs have on the development of 21st century skills?
3. What outcomes do students, parents, and teachers perceive from student participation in STEM related OST programs?

Out-of-School Time Programs

OST programs give students opportunities to extend their learning before and after the school day (Beckett et al., 2009). Less structured than the regular school day, OST programs include a variety of instructional approaches like hands-on activities, inquiry-based learning, field trips, and community exploration experiences. Such activities are typically considered impractical for a large class of students during the regular school day. In Community Schools, OST programs exist as a fundamental approach to promoting equitable access to high quality learning opportunities for all (Maier et al., 2017). These programs are fee free or associated with a minimal cost so that students who are interested in programs can participate with as few barriers as possible. In a research synthesis on OST programs, Eccles and Templeton (2002) reported that students in OST programs experienced the following associated outcomes: higher levels of engagement and retention in school, academic achievement, and improved behaviors.

The researchers linked these outcomes to relationships with peers and adults in the OST context, as well as the sense of belonging inherent in being a part of a group.

Community School Framework

The purpose of community schools is to make education universal *and* equitable for all students (Maier et al., 2017; Partnership for the Future of Learning, 2018). This is accomplished through the provision of the four pillars of community schools: integrated student and family supports, family engagement opportunities, collaborative leadership among school stakeholders and community partners, and expanded and enriched learning time and opportunities. Eliminating or combatting barriers that hinder schooling (i.e. medical needs, food insecurity, poverty, language barriers, etc.) is a critical first step in promoting equity for all students (Dryfoos, Quinn, & Barkin, 2005). Community school coordinators partner with outside organizations to connect families with a variety of resources tailored to the family's basic and complex needs (called wrap-around services). Wrap-around services, provided by partnering community agencies, promote improved student attendance, family engagement, and overall positive school experience (Bartlet & Freeze, 2018). One example of such improved outcomes can be found in Oakland, California (Maier et al., 2017). Around 29% of students in the school immigrated to the U.S. as unaccompanied minors (primarily from Mexico). The integrated provision of academic, OST learning, social services, and youth development contributed to an increase in retention and graduation rates. Additionally, over half of the students took and passed preliminary coursework required for postsecondary education, and college enrollment rates rose from 52% in 2009 to 68% in 2014. This example illustrates how the

Community Schools approach is designed to holistically support student and family success from cradle to career.

STEM Pipeline

A prominent metaphor used in the literature to describe students' attitudes and participation in STEM subjects is the *STEM pipeline* (Bergeron & Gordon, 2015; Lyon, Jafri, & St. Louis, 2012; Marksbury, 2017; Van den Hurk, Meelissen, & Langen, 2019; Wiseman & Herrmann, 2018). This pipeline begins in early childhood as students become interested in problem solving and engaging with the world around them. Those who are provided with early experiences to experiment and explore in STEM areas are likely to seek other opportunities to continue their exploration. The more experience and practice students have working with STEM content, the more motivated and engaged they become in STEM learning. By middle school, the years in which students have more autonomy in their school course selections, students need to have well-developed interests in STEM or they risk exiting the STEM pipeline. Researchers recognize that this model can be problematic and that a "leaky" pipeline exists for women and students of color (Blickenstaff, 2005; Jayaratne, Thomas, & Troutman, 2003; Leboy, 2008). Lack of access and exposure to STEM concepts and opportunities may eliminate students from the pipeline before they have a chance to enter, which is why implementing equity strategies like Community Schools and OST programs for the provision of these opportunities is critical (Lyon, Jafri, & St. Louis, 2012; National Research Council, 2015).

Student Attitudes Toward STEM

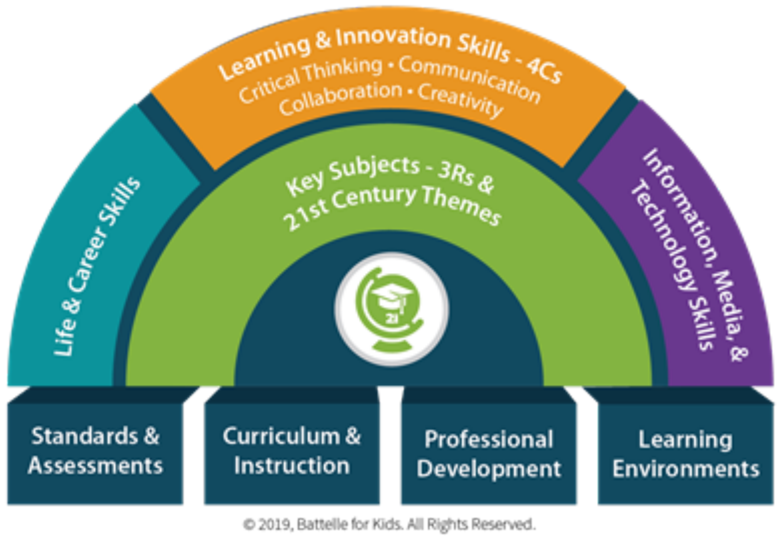
Unfried et al. (2015) define STEM attitudes in terms of self-efficacy and expectancy-value beliefs. Self-efficacy is the perception of influence that an individual has over his or her situation (Bandura, 1986). High self-efficacy occurs when a person feels capable to accomplish a goal, win a game, or create a masterpiece. High self-efficacy is associated with positive academic outcomes especially in the areas of math and science (Scott & Mallinckrodt, 2005; Wang, 2013). The second set of components implicit in STEM attitudes are expectancy-value beliefs. Expectancy-value beliefs are connected to goal-setting potentials. Those with high expectancy-value understand the steps necessary to achieve their goals. They modify their behaviors to maximize the likelihood of goal attainment (Eccles & Wingfield, 2002). Expectancy-value beliefs are associated with long-term academic persistence (Fan, 2011). This two-pronged conception of STEM attitudes provides an important outcome to measure in the provision of OST STEM programs. In terms of future involvement and commitment to STEM careers, this attitudinal outcome is a much more powerful indicator of program success than student academic scores, which are susceptible to many outside influences (Afterschool Alliance, 2011; Wilkerson & Haden, 2014).

21st Century Skills

21st century skills are considered necessary for success in innovative 21st century professions (Battelle for Kids, 2019). Chalkiadaki's (2018) meta-analysis of 21st century skill research in the past decade reveals the emerging awareness that supporting students' skill and dispositional development is a critical component of their academic identities and outcomes. The Framework for 21st Century Learning (see Figure 3.1), which enumerates these skills, was developed by the Partnership for 21st Century Learning in combination with national leaders in political and economic sectors (Battelle for Kids, 2019).

Figure 3.1.

Framework for 21st Century Learning



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The framework incorporates skills in the following three areas: Life and Career skills (like social skills, flexibility, initiative, and leadership skills), Learning and Innovation skills (which include creativity, critical thinking, communication, and collaboration); and Information, Media, and Technology skills. In addition to the skill areas, the framework includes 21st century themes and topics like global awareness and financial, civic, health, and environmental literacy. These skills, dispositions, and literacy themes are most effectively taught through hands-on learning experiences, collaboration with peers, and with content that is meaningful, relevant, and connected to students' lives outside of school (Darling-Hammond, 2006; Ledward & Hirata, 2011). Teaching students pieces of knowledge is a straightforward process with outcomes that can be applied in limited ways (i.e. the recitation of knowledge). On the other hand, supporting the development of 21st century skills promotes behaviors necessary to seek and cultivate knowledge in a variety of areas, and to navigate the processes associated with learning and apply that knowledge in the real world.

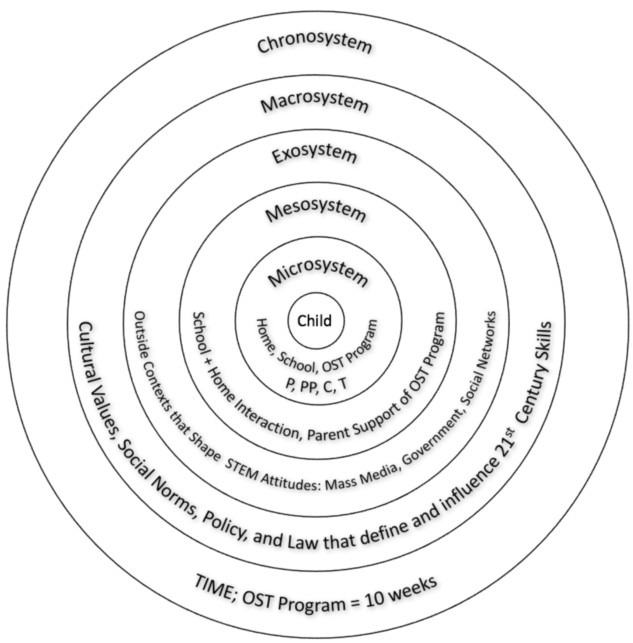
Bioecological Systems as Supports for STEM Learning

The community school setting informed the selection of the theoretical framework for this study, which was inspired by Bronfenbrenner's (1979) bioecological model of human development. Bronfenbrenner and Morris (2006) explain that an individual's development involves four dynamic properties: proximal processes (responsiveness and supportive interactions), people, contexts, and time. The dynamic properties of development call for an equally dynamic and comprehensive approach to education that is inclusive of the student, the student's family, and the surrounding community. High-quality STEM experiences contribute to a comprehensive and supportive approach to education (McClure et al., 2017). Community schools support student development and the wellbeing of the family through the provision of layered resources including OST programs (Quinn, 2005).

An earlier version of Bronfenbrenner's theory (1977), the ecological systems theory, proposes that there are multiple contextual levels that influence a child's development. These contexts include the microsystem, mesosystem, exosystem, and macrosystem. When students are exposed to positive STEM messages and influences at every contextual level, they are predisposed to developing a positive affect toward STEM activities and content (McClure et al., 2017). Figure 3.2 depicts the widely referenced concentric circle model to connect the ecological systems theory and the development of positive STEM attitudes and 21st century skills. Parents and teachers who convey positive attitudes toward STEM at the microsystem level positively influence students' perceptions of STEM. McClure et al. (2017) refer to parents and the home as "the gateways to STEM" (p. 20) and explain that parents who support STEM learning at home help to build self-efficacy toward STEM while also averting occurrences of math anxiety or negative dispositions toward STEM and problem solving. Students who can engage in positive STEM experiences with their friends at home and school (the mesosystem level), and whose parents are engaged in their school lives are often exposed to frequent and varied experiences that will capture their interests.

Figure 3.2.

STEM and OST programs explained through ecological systems theory



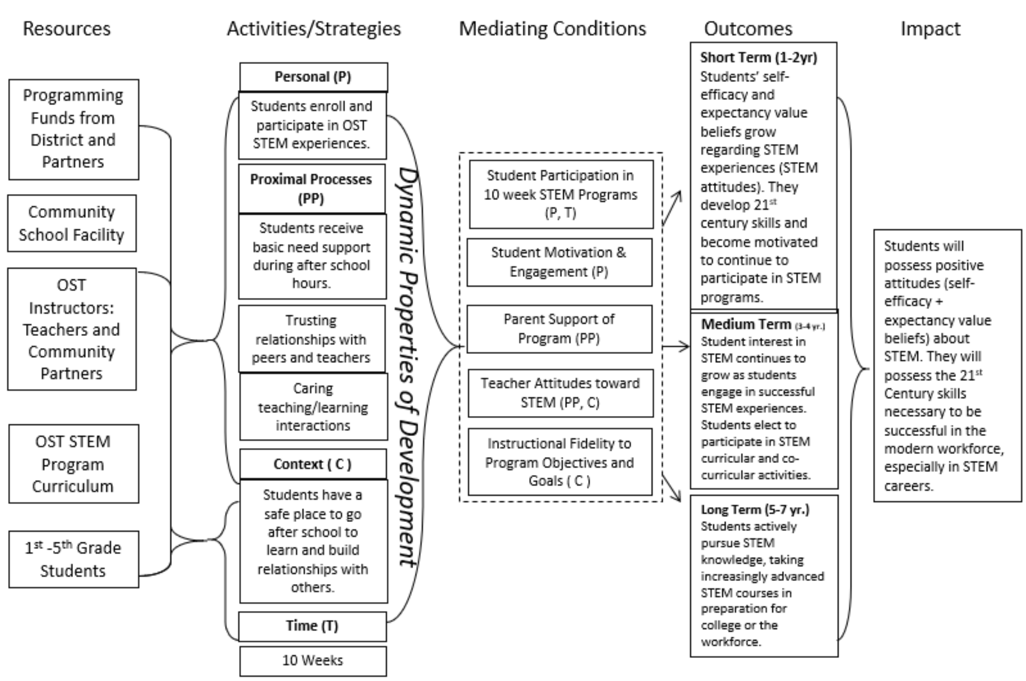
Though the exosystem and macrosystem levels are more contextually distal in relation the student, they are still important influences on STEM education. McClure et al. (2017) explain that research and policy strongly influence STEM education at the exosystem level. Advocacy for equitable and high-quality STEM is a critical step in promoting diversity in STEM professions. Finally, working to shift cultural and social paradigms to prioritize high-quality curricular and co-curricular educational programs for all students (including equal access to STEM opportunities) promotes STEM at the macrosystem level.

STEM OST Program Logic Model

Applying the bioecological theoretical framework, the researcher developed a STEM OST program logic model at the onset of the study to predict change (Knowlton & Phillips, 2013). The theory of change, shown in Figure 3.3, identified the resources in place at the community school that included a community school facility with instructors and STEM professionals who were interested in working with first through fifth grade students.

Figure 3.3.

STEM OST program logic model



The activities and strategies that contributed to student outcomes incorporated the four properties of development (Bronfenbrenner & Morris, 2006). Participation in an OST program involved a personal decision between the student and family (microsystem). Together, the guardian(s) and student took the steps necessary to enroll in the program (i.e. completing and submitting the enrollment form). Once the student had been accepted and placed into an OST program, she was provided with proximal process and context supports. Proximal processes included the development of trusting relationships with an OST teacher who conveyed positive messages about STEM and provided support for the student during OST time. Contextual supports included high-quality STEM instruction in a safe place where relationships with others were built. Another important bioecological property that influenced the development of STEM attitudes and 21st century skills was time. Over the course of ten weeks, students had time and opportunities to engage in STEM learning with others, participate in experiments and problem-solving activities, and receive a variety of supports that helped to positively shape their attitudes toward STEM.

The mediating conditions in the study included student attendance and participation over the course of the 10-week program, students' levels of motivation and engagement, amount of parent support of the program, teachers' expressed attitudes toward STEM, and the instructional fidelity to the program objectives and goals. Each of these mediators linked back to the bioecological properties (see Figure 3.3). The short-term outcomes evaluated in this study included students' improved attitudes toward STEM as well as the development of 21st century skills. Also important, though not directly evaluated in this study, were the medium-term outcomes, which included students' motivation to continue participating in STEM opportunities throughout their school careers. Long-term outcomes included students' openness to pursuing STEM opportunities later in life as they become part of the 21st century workforce.

Research Questions

The guiding research questions for this mixed methods, quasi-experimental study were as follows. For students at a community school:

1. What effect do STEM related OST programs have on students' attitudes toward STEM learning?
2. What effect do STEM related OST programs have on the development of 21st century skills?
3. What outcomes do students, parents, and teachers perceive from student participation in STEM related OST programs?

Based on theory and research related to the questions in this study, it was hypothesized that students' participation in ten-week, high-quality OST STEM programs would positively impact attitudes toward STEM and students' development of 21st century skills. The perceptions of students, parents, and teachers were helpful in revealing insights about specific gains made in the programs, especially in the 1st through 3rd grades.

Methods

A variety of evaluative methods including the use of survey instruments, teacher interviews, and parent and student focus groups contributed to the study's mixed methods design.

Participants

For this study, the population of interest was a convenience sample of 117 first through fifth grade students (ages 6-10) at a diverse, Title I community school with 92.2% of students in the school receiving free or reduced lunch. The student population was comprised of 57.1% Hispanic and Latinx, 14.4% African American, 11.6% Caucasian, 7.3% Asian, 2.5% Native American, and 7.0% students with two or more races. Ten different native languages were represented within the student population with Spanish as the most prominent. In the 2017-18 school year, 53% of the 860 students were involved in at least one of 20 after school programs offered four days per week (Monday through Thursday), each semester. Pseudonyms were used for all participants.

Students. Student participants in the treatment group included those students who enrolled in STEM programs and received parent consent (in addition to student assent) to be a part of the study. Entry into these programs occurred in the order that student enrollment forms were received by the school office, based on the school's *first come, first served* OST placement protocol. Once a club reached its capacity (approximately 15 students, depending on the program), students were added to a wait list and granted their second or third enrollment choice indicated on the enrollment form. The treatment group included 60 students who enrolled and were placed in STEM OST programs. Of the 60 students in the treatment group, 39 were 1^{st} through 3^{rd} grade students and 21 were 4^{th} through 5^{th} grade students; 48% were girls, 61.7% were Latinx, 21.6% African American, 10% Caucasian, 5% Asian, and 1.7% Native American.

The control group in this study was comprised of 57 students whose parents consented to their participation in the study and who attempted to enroll in STEM clubs but were waitlisted (due to the club reaching capacity) and placed in their second or third choice, a non-STEM program. This ensured that students from both the treatment and control groups had similar interests and parent enrollment support regarding STEM OST programs. There was almost an even split between grade levels in the control group with 29 students in 1st through 3rd grade and 28 students in 4th through 5th grade; 59.6% were female, 52.6% were Latinx, 21.1% African American, 17.5% Caucasian, 7% Asian, and 1.8% Native American. Both treatment and control groups were fairly representative of the broader school community.

Before the study took place, the researcher met with the school district to acquire district consent for the study (which was granted). During that meeting, the researcher also gained district approval to seek parent and student consent to participate in the study. IRB approval was then acquired. Once students were placed in programs, IRB consent forms for study participation were sent home to both parents/guardians and students. Each consent form included both English and Spanish versions. Consent to participate in the study was optional and procured *after* students were placed in their programs so that parents and students did not feel that program enrollment was related to consent.

Teachers. Pre-K through 5th grade teachers and paraprofessionals at the school applied to teach in the after school programs and be paid hourly for their planning and teaching time. Teacher salary costs were covered by grants and donations made by community partners. Costs of *community-led* OST programs were supported with grant funding or covered by the community partners. Before the beginning of the study, the researcher held a meeting with OST program teachers and partner educators about the study purpose as well as the level of involvement required for participation in the study (including lesson plans, interviews, and periodic observations). After the informational session about the study, teachers made final decisions about which programs they would apply to teach. Twenty-nine teachers were hired to teach twenty-three OST programs (six programs had two teachers; see Table 3.1). At that time, optional consent forms to participate in the study were offered to all OST program teachers. All 29 teachers consented to be a part of the study.

Parents. Parents of students in 1^{st} through 5^{th} grade who enrolled their student(s) in STEM or non-STEM OST programs and who consented to be a part of the study were randomly selected and invited to participate in one of four focus groups included in the study. The focus groups included 1^{st} – 3^{rd} control, 1^{st} -3^{rd} treatment, 4^{th}-5^{th} control, and 4^{th}-5^{th} treatment. Phone calls in English and Spanish, as well as in-person communication at arrival and dismissal times, were helpful in informing parents about the study and gaining parent consent. Twenty-six parents of students in OST programs (13 STEM, 11 non-STEM) participated in the focus groups.

Table 3.1

OST Program Offerings

Program Name	Category	Grade	Sessions per week	Number of students	Teacher type
Connect Block Art (2 sections)	Non-STEM	1st-3rd	1	15	School
4-H, Farm Fun	Non-STEM	1st-3rd	1	15	Community
Readers Theater	Non-STEM	1st-3rd	2	13	School
Camp Fire Starflight	Non-STEM	1st-3rd	1	12	Community
Sewing	Non-STEM	4th-5th	1	8	School
Origami	Non-STEM	4th-5th	1	15	School
Choir and Instruments	Non-STEM	4th-5th	1	15	School
Gardening (2 sections)	Non-STEM	4th-5th	2	20	Community
Sports Club	Non-STEM	4th-5th	1	20	Community
Running Club	Non-STEM	4th-5th	1	18	School
Camp Fire Adventure	Non-STEM	4th-5th	1	12	Community
Song Writing and Dance	Non-STEM	4th-5th	1	15	Community

Program Name	Category	Grade	Sessions per week	Number of students	Teacher type
Soccer	Non-STEM	4th-5th	2	23	School
Engineering with Connect Blocks (2 sections)	STEM	1st-3rd	1	15	School
Art and STEM	STEM	1st-3rd	1	15	Community
Chemistry	STEM	1st-3rd	1	15	Community
STEM Club	STEM	1st-3rd	1	15	School
Coding and Robotics 1	STEM	1st-3rd	1	15	School
Coding and Robotics 2	STEM	4th-5th	1	14	School/Community
Robotics	STEM	4th-5th	2	10	School
City Engineering	STEM	4th-5th	1	10	Community
Chess and Computers	STEM	4th-5th	1	13	School
Tree School	STEM	4th-5th	1	14	School/Community

Setting

The community school where the study took place was part of a public school district in the Midwest. The school featured an onsite community medical clinic, co-located behavioral health specialists, a large community garden, and regular (weekly) opportunities for family and community engagement. Additionally, the school had an extensive group of community partners who provided programming and resources for a variety of free after school programs for students.

Treatment and Dosage

The treatment in this mixed methods study was the provision of STEM after school programs for first through fifth grade students. Of the 23 programs provided, 10 were STEM and 13 were non-STEM programs (see Table 3.1). Three sources of data were used to determine whether a program was characterized as STEM or Non-STEM: teacher classification (teacher identified program as STEM or Non-STEM), program lesson plans, and observation data. Program sessions occurred once or twice weekly for ten weeks. Programs were divided into 1st through 3rd grade and 4th through 5th grade age groups. Program sessions took place for 1.5 hours from 2:45 until 4:15 PM. Snacks were provided by the district's child nutrition department and bus transportation was provided at the end of program time. Students in the sample (both treatment and control) attended an average of 91% of program sessions offered (dosage) throughout the duration of the study.

Data Sources and Collection Procedures

Quantitative Instruments and Procedures

The sources of quantitative data used to answer questions one and two, were the pre- and post- PEAR Common Instrument Suite (CIS) surveys and S-STEM standardized and adapted surveys of student STEM attitudes and 21^{st} century skills (Friday Institute for Education Innovation, 2012; PEAR Institute, 2017). Both surveys were administered digitally (on tablets) during the first and last sessions of programming (weeks 1 and 10).

PEAR CIS. The PEAR CIS is a survey designed to measure STEM attitudes and 21^{st} century skills (PEAR Institute, 2017). The survey, developed by the PEAR Institute at Harvard Medical School, McLean Hospital, is intended for OST program evaluation (PEAR Institute, 2016). Each survey question includes a 4-item Likert scale. The survey has two outcome categories: STEM-Related Attitudes and 21^{st} century skills/social emotional learning (SEL). Six subscales include STEM attitudes, STEM identity, critical thinking, perseverance, relationships with peers, and relationships with adults. The STEM attitudes subscale includes items about STEM interest, identity, career interest, career knowledge, enjoyment, and STEM activities. The 21^{st} century skills/SEL subscales include relationships with adults and peers, perseverance, and critical thinking. Two age-appropriate versions were used in the study, one for K-3^{rd} grades and the other for 4^{th}-5^{th} grades. The K – 3^{rd} grade version was shorter and created for use with students in K through 3rd grades with read aloud protocol; similarly, the longer version for 4th through 5th grade students was found to be valid and reliable for use with older students. The K-3rd version only included the STEM attitudes subscale (15 items) while the 4th-5th grade version had 39 items (STEM attitudes = 15, STEM Identity = 7, critical thinking = 5, perseverance = 4, relationships with peers = 4, and relationships with adults = 4). [1]

S-STEM 21st century skills subscale survey. The S-STEM is a standardized survey of student dispositions toward each category of STEM, as well as perceptions of their development of 21st century skills over the course of the program (Friday Institute for Education Innovation, 2012). For this study, only the 21st century skills subscale was used. The S-STEM 21st century survey subscale included a 5-item Likert scale for each of the 11 questions about 21st century skills (see Table 3.3 for subscale items; Friday Institute, 2012). The survey was administered along with the PEAR CIS as a pre- and post- survey to all students in the control and treatment groups at the beginning of programming and again during the final session of the ten-week program. Permission to use the S-STEM 21st century skills subscale was obtained from Friday Institute for Educational Innovation, the developers of the survey.

Adapted survey of 21st century skills for 1st -3rd grade students. The original S-STEM measure was designed for 4th and 5th grade students (Friday Institute, 2012). For this reason, the researcher, with permission from the Friday Institute, adapted the measure for appropriateness for 1st through 3rd grade students who have varied reading

[1] Permission to use the CIS was obtained from the PEAR Institute at Harvard Medical School and McLean Hospital. Any opinions, findings, and conclusions or recommendations expressed in this article are those of the author and do not necessarily reflect those of the PEAR Institute, Harvard Medical School, or McLean Hospital.

and comprehension levels. These adaptations included the simplification of wording in the S-STEM items, the verbal administration of the survey, the reduction of the 5-item Likert to a 2-item "yes" or "no" selection, and the inclusion of emotion faces associated with both options (smile for "yes" and frown for "no"). A small group read aloud protocol was followed for survey administration. Mellor and Moore (2013) recommended such adaptations for assessment of young children, which was why the adaptations were made.

Survey administration. OST program teachers administered pre and post surveys to their students during the first and last sessions of programming. Before the start of programs, teachers attended a meeting to review the survey instructions and address questions about how to administer the survey to their students. The PEAR CIS and S-STEM surveys were input into a Qualtrics digital form so that all students could use an electronic tablet to answer their surveys one item at a time. Teachers read aloud a script (written by the survey developers) at the beginning of each survey section. Digital surveys for 1st through 3rd grade students were administered by teachers in small groups with read aloud protocol. Following data collection, all data was imported into the Statistical Package for the Social Science (SPSS) 17.0 for analysis.

Qualitative Data and Procedures

Qualitative data sources were an important part of the study used to answer the third research question. Qualitative methods included program observations, analysis of program plans, student focus groups, parent focus groups, and teacher interviews. Collection of data was ongoing and simultaneous throughout the 10-week programs. Jottings of informal thoughts and connections made throughout the data collection process were included in the researcher's field notebook (Emerson, Fretz, & Shaw, 2011). The information recorded in the field notebook was helpful for data collection purposes and for generating a synthesis of findings and triangulating the various sources of data collected throughout the duration of the study.

Program lesson plans and observations. Before the beginning of programs, OST program teachers developed program plans that featured SMART (specific, measurable, attainable, relevant, and time-oriented) goals associated with student outcomes as well as week-by-week activities. During weeks 3, 6, and 9, program observations were conducted for nearly all programs (due to weather cancellations, two programs only had two observations). During the observations, which lasted about 15 to 20 minutes each, the researcher noted program session activities, student behaviors, teacher behaviors, and interactions between teacher and students and among peers. Observations were recorded on an observation guide form. Lesson plans and observation guides were transcribed, coded, and analyzed along with the other qualitative data.

Student and parent focus groups. During weeks 8 and 9 of programming, 7 student focus groups (3 STEM, 4 Non-STEM) and 4 parent focus groups (2 STEM, 2 Non-STEM) were conducted. A parallel guide list of questions was used to ensure that both parents' and students' perspectives on OST topics were captured as equally as possible. For example, students were asked to share how being a part of their program changed the ways that they thought about STEM. Parents were asked a similar question about how their student's program involvement changed the way that their child thought about STEM. There were nine guiding questions about social skills, STEM interest, and parents/students' perceptions of learning over the course of programs.

To form the focus groups, names of all consenting parents and students in the control and treatment groups were added to an Excel spreadsheet and organized by the student's grade. Focus groups were designated for 1st through 3rd grade control group, 1st through 3rd grade treatment group, 4th through 5th grade control group, and 4th through 5th grade treatment group. Parent and student participants were randomly assigned a number using the randomization function in Excel. Eight students attended each focus group, which lasted around 20 minutes and were held right after school and just before the start of programs on 7 different days.

Parent(s)/guardian(s) were invited to the focus groups in chronological order based on their randomized number until ten RSVPs were received for each group. Parents of multiple students were only able to RSVP for one focus group. The groups lasted for 30 to 45 minutes directly after programs on four different days. Invitation efforts included hard copy and digital invitations in English and Spanish distributed via text message, e mail, and printed flyers shared with students to give to their parents. Each parent focus group had 5 to 10 parent participants and a Spanish/English interpreter translated each meeting. All student and parent focus groups were recorded for transcription and later analysis.

Teacher interviews. After the end of programs, all 28 teachers were interviewed about their experiences teaching OST programs. A 10-item question list lent to the semi-structured nature of the interviews, which included questions like, "How did teaching this program change the way that your student felt about STEM?" and "How does the content of your program relate to school or home?" Questions were intended to capture teachers' perceptions and feelings about their students' outcomes associated with program participation. Each interview, which lasted around 30 minutes, was recorded for transcription and later analysis.

Analysis methods

Quantitative Analysis

Pre- and post- survey data were analyzed using SPSS 17.0 software. Cronbach's alpha values were found for each subscale. The Common Instrument STEM Interest subscale ($\alpha = .82$), designed to capture student interest in STEM and STEM-related activities, included 15 items taken by all student participants, 1st through 5th grade. Cronbach's alpha values for 4th and 5th grade subscales including STEM Identity (5 items; $\alpha = .82$), Critical Thinking (5 items; $\alpha = .79$), Perseverance (4 items; $\alpha = .72$), Peer Relationships (4 items; $\alpha = .79$), and Adult Relationship (4 items; $\alpha = .75$) were found to be highly reliable as well. The Cronbach's alpha value for the adapted S-STEM measure for 1st through 3rd grade students was very low ($\alpha = .59$), thus, the measure was found to be unreliable and had to be eliminated from the study. The original S-STEM 21st Century Skills subscale for 4th – 5th grade students had high reliability (11 items; $\alpha = .91$).

Descriptive statistics revealed that most of the pre- and post- data was negatively skewed and typically platykurtic. Therefore, a Wilcoxon Signed-Rank Test was the most appropriate analytical approach to compare pre- and post-test scores from the control and experimental groups (Warner, 2013). The threshold level of significance (p value) was 0.05.

Qualitative Analysis

A robust amount of qualitative data was collected throughout the study including 23 program plans, 67 program observations, 29 teacher interviews, 7 student focus groups, and 4 parent focus groups. All in-person communication was recorded (permissions for recording were included in the IRB consent forms) and transcribed for analysis. Member checks were conducted with all interviewees. Before coding, the researcher read through all transcripts and became familiar with the data through an immersive review process. The initial cycle of coding involved line-by-line, emergent coding (Bazeley, 2013). A second cycle of coding helped to refine the emerging codes and organize them into themes. Once all the data had been analyzed, findings were triangulated across data sources and between the quantitative and qualitative sources. The third and final cycle of coding was the crafting of the narrative of findings, which incorporated the relevant themes and ideas that had surfaced among and across the different data types. To preserve the objectivity and reliability of the findings from qualitative and quantitative data sources, peer audits were conducted at multiple points throughout the study (Anney, 2014).

Findings

After analyzing the data, a few key findings emerged. First, students who participated in STEM programs demonstrated change from pre- to post- in STEM identity. The CIS STEM Identity subscale was designed to capture students' perceptions of themselves as individuals who have the capability and skill needed to engage in STEM related work (PEAR Institute, 2016). Students who participated in Non-STEM programs demonstrated a marginally significant change in critical thinking skills and strongly significant growth on the 21st century skill self-report subscale.

Quantitative Measures

STEM attitudes and identity in STEM programs.

Table 3.2

CIS Subscales pre- test to post-test Wilcoxon signed-ranks test results

Subscale	STEM Programs						Non-STEM Programs					
	Mean Ranks				Z Score	Asymp. Sig. (2-tail)	Mean Ranks				Z Score	Asymp. Sig. (2-tail)
	Pre	S.D.	Post	S.D.			Pre	S.D.	Post	S.D.		
STEM Interest Subscale (1st – 3rd)	3.16	.66	3.30	.50	-1.377	.169	3.25	.34	3.3	.49	-1.12	.264
STEM Interest Subscale (4th – 5th)	3.35	.46	3.25	.67	-.392	.695	3.24	.45	3.29	.39	-.878	.380
STEM Identity Subscale (4th – 5th)	2.89	.64	3.22	.63	-2.800	.005**	3.10	.49	3.01	.57	-.461	.645
Critical Thinking Subscale (4th – 5th)	2.19	.69	2.29	.66	-.750	.453	2.14	.57	2.31	.55	-1.646	.100†
Perseverance Subscale (4th – 5th)	2.18	.61	2.33	.58	-1.145	.252	2.21	.41	2.27	.58	-.517	.605
Relationships- Peers Subscale (4th – 5th)	2.30	.63	2.29	.72	-.131	.896	2.21	.61	2.33	.61	-.447	.655
Relationship- Adults Subscale (4th – 5th)	1.98	.75	2.25	.75	-1.424	.154	2.07	.72	2.18	.62	-.505	.614

Note: p=.05-.10†, p= .01 to 0.05*, p=.001 to 0.01**, $p < 0.001$***

A Wilcoxon signed-ranks test indicated that for 4th and 5th grade students who participated in STEM OST programs (n= 21), post test scores were significantly higher than pre-test scores on the STEM Identity subscale (Z= -.28, p= .005). This finding is corroborated by findings from a meta-analysis of STEM OST programs conducted by Young, Ortiz, and Young (2017). In the studies, students' participation in STEM programs led to increased interest and more positive attitudes toward STEM. Similar findings were also featured in the Afterschool Alliance (2011) report on STEM programs and their capacity for supporting continued interest and STEM identity formation.

Another marginally significant finding from the PEAR CIS measure was that for 4th and 5th grade students who participated in Non-STEM programs (n=28), post test scores were slightly significantly higher than pre-test scores on the Critical Thinking Subscale (Z= -1.646, p = .100).

21st century skills in non-STEM programs.

Table 3.3

S-STEM Subscales (4^{th}-5^{th} Grades) pre-test to post-test Wilcoxon singed ranks test results

Survey Item	STEM Programs						Non-STEM Programs					
	Mean Ranks				Z Score	Asymp . Sig. (2-tailed)	Mean Ranks				Z Score	Asymp. Sig. (2-tailed)
	Pre	S.D.	Post	S.D.			Pre	S.D.	Post	S.D.		
I am confident I can lead others to accomplish a goal.	4.14	.91	3.86	1.11	-1.164	.244	3.85	.99	3.86	1.11	-.080	.936
I am confident I can encourage others to do their best.	4.16	.77	4.05	1.11	-.378	.705	4.19	.94	4.14	.93	-.121	.904
I am confident I can produce high quality work.	3.9	.85	3.90	1.00	-.073	.942	3.84	.69	4.29	.71	-2.840	.005**
I am confident I can respect the differences of my peers.	4.19	.68	4.24	.94	-.258	.796	4.04	.90	4.32	.72	-1.347	.178
I am confident I can help my peers.	4.25	.79	4.33	.91	-1.265	.206	4.21	.74	4.46	.58	-1.615	.106
I am confident I can include others' perspectives when making decisions.	3.90	.77	4.19	1.03	-1.438	.150	3.92	.74	4.18	.48	-1.513	.130
I am confident I can make changes when things do not go as planned.	3.81	.93	3.76	1.34	-.136	.892	3.79	1.00	4.04	.84	-1.498	.134
I am confident I can set my own learning goals.	4.24	.83	4.19	1.08	-.042	.967	4.04	.94	4.50	.70	-1.936	.053*
I am confident I can manage my time wisely when working on my own.	4.00	1.0	4.05	1.16	-.036	.971	3.75	.93	4.25	.80	-2.446	.014*
When I have many assignments, I can choose which ones need to be done first.	4.00	1.0	4.14	.96	-.577	.564	4.04	.90	4.39	.73	-2.138	.033*
I am confident I can work well with students from different backgrounds.	4.14	.79	4.38	.67	-1.098	.272	4.32	.82	4.39	.63	-.139	.889
Overall Mean of S-STEM 21^{st} Century Skills	4.07	.50	4.10	.85	-.374	.708	3.9	.51	4.26	.46	-3.955	.000***
Composite Score of S-STEM 21^{st} Century Skills Subscale	43.95	5.6	45.10	9.3	-.806	.420	42.14	6.59	46.82	5.03	-3.118	.002**

Note: Survey is from the Friday Institute for Educational Innovation (2012)
p= .01 to 0.05*, *p*=.001 to 0.01**, $p < 0.001$***

As mentioned previously, S-STEM 21^{st} Century Skills subscale was found to be highly reliable (11 items; α = .914). Unfortunately, the adapted S-STEM (fewer Likert options) for 1^{st} through 3^{rd} grade students was not found to be reliable (α = .59), thus, it was dropped from the study. Analyzing data produced from the original S-STEM version revealed some significant findings (individual survey items from the 21^{st} century subscale are included in Table 3.3). A Wilcoxon signed-ranks test revealed that 4^{th} and 5^{th} grade students who participated in Non-STEM programs (n= 28), had significantly higher post-test scores than pre-test scores on the 21^{st} century skills subscale (Z= -3.955, p <.001). An item level analysis revealed significant increases in pre to post surveys in questions on the following topics: production of high-quality work, goal setting, time management, and task organization/completion.

Qualitative Findings on Perceptions of Program Outcomes

With a small sample size, triangulation of multiple types of data is crucial (Mertens, 2015). The qualitative findings in this study add nuance and incorporate multiple layers of perspectives related to OST programs and outcomes.

Findings from STEM programs. The qualitative data revealed that parents, students, and teachers identified different outcomes associated with participation in STEM programs. Through technology and engineering-focused challenges and activities, students reported that they learned how to solve problems with their peers. When students spoke about getting to work together, they used positive phrases and described friendships that were formed in their programs that would not have formed during the regular school day (since programs were multi-age).

Parents focused more on the ways that OST programs shaped their child's knowledge, skills, and identities as individuals who are capable of doing STEM work. The following examples from a father, Fernando, and son, Joe, captures the essence of the qualitative findings related to growth in STEM identity associated with program involvement.

> When my son does things at home, I wonder out loud, "Hey, how did you do that?" He says, "I know how to do this, and I know how to take apart a cell phone and put it back together." He is learning how to solve problems on his own and to ask questions that he can think about solutions. But he benefits from having the opportunity to experience new things in his clubs in a safe way. (Fernando)

> In my [robotics] class, we're building a robot. We are programming and we build it together. We use teamwork and sometimes the teacher puts us in a group of three or four, but we have a lot of fun doing it all together. (Joe)

Joe clearly felt confident enough to communicate his knowledge and capability to his father, who recognized that OST programs gave him time and space to explore his technological interests. This finding aligns with the quantitative findings about growth in STEM identity.

STEM program teachers focused primarily on supporting students' conceptualization of STEM in addition to social skill and dispositional development. Magda, City Engineering teacher, stated:

> It was important to point out all the different things that are included in STEM because I think a lot of [the students] really only think of like science and math. It's important to show that [areas of STEM] are interconnected and to broaden students' scope of what STEM is.

A few teachers recognized that students did not fully understand STEM and that OST programs afforded opportunities to experience what STEM looked and felt like. Interestingly, many of the youngest students in 1st and 2nd grades still did not fully understand what STEM was, even at the end of programming. In one case, a little boy explained that he liked Robotics more than STEM. When the researcher shared that robotics *is* STEM, he replied in a surprised manner, "It is?" Teachers also focused on the dispositional outcomes associated with collaborative work in OST programs. Stephen emphasized peer mentorship as a valuable way to promote communication skills and problem solving.

> One of the benefits that's unique to afterschool programs is having multi-age classrooms. I'm very big on the social aspect of my classroom and so anything that I can do to try to help kids to be able to communicate with each other better, I'm all for… It was cool because the older ones were able to help the younger ones. They were working towards a common goal. Having that in the afterschool program is a way that teachers can also encourage kids to help each other out and to work together. So, I think that's really valuable.

Other teachers also emphasized the growth of social emotional skills like confidence, empathy, and patience resulting from collaborative group work. Data from observations and lesson plans revealed that STEM program teachers incorporated experiential learning; intentional questioning; and information, communications, and technological literacy as instructional components to support new STEM learning.

Findings from Non-STEM Programs. The qualitative and quantitative findings from Non-STEM programs corroborate one another. Students, teachers, and parents emphasized 21st century skills as outcomes associated with Non-STEM OST program involvement. Many Non-STEM programs were sports-focused and students frequently mentioned communication, teamwork, and collaboration as important outcomes from their participation in programming. In working and playing together, students learned the value of interpersonal skills and persistence.

Parents of students who participated in Non-STEM OST programs focused more on social emotional and 21st century skill outcomes like leadership, self-advocacy, and confidence that developed over time. Similarly, program teachers identified situations that stimulated growth of collaboration, creativity, and the accomplishment of collective goals. Maegan, the Readers Theater teacher, expressed the following.

> They work as a team together and create something that actually flows from the beginning to the end. There's a structure to it and they have to follow that structure and rely on each other. And if they don't follow that structure and work as a team, it falls apart.

Interestingly, the qualitative findings revealed growth in the 21st skill areas of collaboration, communication, and teamwork, whereas the survey data revealed growth in task and goal-oriented areas. Research shows that there is a connection between the two. Beckett et al. (2009) recommends collaborative learning opportunities as supports for academic growth, goal completion, and problem solving.

Discussion

STEM Attitudes and 21st Century Skills

Student participation in OST programs has been shown to promote student engagement, positive attitudes toward school, and interest in academic topics (Beckett et al., 2009). With greater flexibility, more opportunity for student and teacher autonomy, small class sizes, and multi-age groupings, afterschool programs are designed to promote more diverse learning opportunities than during the typical school day in traditional classrooms. In this study, students who participated in STEM programs demonstrated an increase in their identification as individuals who engaged in STEM activities. This is important as STEM attitudes serve as stronger predictors of later STEM pursuits and successes than any academic measures like grades or test scores (Afterschool Alliance, 2011; Krishnamurthi, Ballard, & Noam, 2014). Findings associated with Non-STEM programs revealed that student growth was not limited to STEM or academic programs alone. Participation in Non-STEM programs promoted the development of valuable 21st century skills. The mixed methods nature of the study revealed diverse approaches to capturing student growth in both program types. Though students in STEM programs did not demonstrate the same growth in 21st century skills as their peers in Non-STEM programs as measured by surveys, focus groups revealed outcomes that the surveys were not able to capture (Cresswell & Clark, 2018).

Nuance of Mixed Methods Research for OST programs

In a setting where community engagement is held as one of the highest priorities, focus groups and interviews served to identify OST program outcomes and to promote communication among all members of the school community. During one of the focus group sessions, a grandmother shared, “I think that this meeting is great. I’ve been in a focus group before, but this is the first one here at the school. I think it is great- allowing us to share our input and feedback.” Another parent echoed that she would be interested in having regular meetings to talk about students’ learning during after school programs. Though unexpected, this finding was an important aspect of the study and speaks to the value of qualitative data in adding layers of nuance to quantitative findings (Cresswell & Clark, 2018). Surveys and quantitative measures have an important place in educational research, but when it comes to research in community schools, qualitative methods are essential in supplementing quantitative findings and capturing a holistic picture of student learning with many voices and perspectives represented.

Challenges Associated with OST Evaluation

Program evaluation is a critical part of OST program planning, development, continuation, and expansion (Wilkerson & Haden, 2014). However, there are challenges associated with identifying the right measures to capture outcomes. The use of survey measures to evaluate young students' (1st through 3rd grade) perceived outcomes, provided a challenge in this study. There are a very few valid and reliable self-report measures that can be effectively used with young children (Murchison et al., 2019). Adapting measures intended for older children is not always the most effective or appropriate way to address this gap (as evidenced in this study). In their exploration of the variety of challenges that plague OST program evaluation, Murchison et al. (2019) explain that using typical "school-day approaches" to evaluate OST programs can be "disastrous" since the settings, resources, sample sizes, and limitations are so distinctly different. Other issues with STEM self-report measures involve response-shift bias (Nakonezny & Rogers, 2005). This occurs when participants' self-reported responses change over time because their understanding of the construct changes from pre to posttest due to the experiences that occur within the treatment or program. Nakonezny and Rogers (2005) and Krishnamurthi, Ballard, and Noam (2014) recommend retrospective evaluation to control for this phenomenon. More research in the area of OST program evaluation is needed to address these gaps.

Limitations

This study included a small convenience sample of students, parents, and teachers. Though the sample size was appropriate for the qualitative components of the study, it hindered the generalizability of the quantitative findings. Additionally, the multiple statistical tests required for the quantitative segment of the study increased the possibility for type 1 errors, the rejection of a true null. A larger sample size would also allow for more complex analyses of the data. An obvious limitation was the mis-adaptation of the S-STEM for 1st through 3rd grade students. This rendered the measure unreliable and not usable for the study. Identifying a more appropriate measure would have been ideal and is recommended for future studies. Finally, the OST programs were only ten weeks long, which may not be long enough to influence student attitudes and 21st century skills long term. However, students, parents, and teachers did report that OST programs provided meaningful experiences that promoted positive outcomes and sparked new interests for many students.

Conclusion

Many schools have implemented OST programs to help provide students with opportunity and time to complete their homework and support academic learning (Afterschool Alliance, 2015; Becket et al., 2009). Recent research reveals that this after school program time holds much more potential for students than simply homework help time. In community schools, OST programs are an important part of the equity strategy to provide rich learning opportunities for all students. In a time where advancement, innovation, and STEM exploration are high on the national agenda, OST programs provide an ideal opportunity for students to make decisions about their learning and cultivate knowledge and skills alongside peers who are interested in similar areas. Using OST program time to equip students with the 21st century skills necessary for postsecondary endeavors and the modern workforce is critical, especially since after school time allows for more innovative and flexible methods of instruction and learning (Durlak & Weissberg, 2007).

Once an innovative program has been delivered, it is important to capture the growth that has occurred over the course of the intervention or program. The implications of this study pertain to program evaluation in community school settings. Recognizing that quantitative measures and methods are limited in their capacities to identify all outcomes and factors related to the learning that occurred over the course of an OST program (limited to the measurement tool or researcher's survey question topics), qualitative measures add layers of personalization and nuance to the data. Focus groups and interviews allow participants time and space to process their learning, communicate with others about their experiences, and provide more depth to the findings by contributing their perspectives. Incorporating both quantitative and qualitative research in OST program evaluation in community schools promotes a holistic understanding of learning that elevates the voices within the school community.

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APPENDIX A: PROSPECTUS

UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE EFFECTS OF STEM OUT-OF-SCHOOL TIME (OST) PROGRAMMING ON THE DEVELOPMENT OF STEM ATTITUDES AND 21ST CENTURY SKILLS OF COMMUNITY SCHOOL STUDENTS

A PROSPECTUS

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

LAURA A. LATTA
Norman, Oklahoma
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THE EFFECTS OF STEM OUT-OF-SCHOOL TIME (OST) PROGRAMMING ON THE DEVELOPMENT OF STEM ATTITUDES AND 21ST CENTURY SKILLS OF COMMUNITY SCHOOL STUDENTS

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF INSTRUCTIONAL LEADERSHIP AND ACADEMIC CURRICULUM

BY

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Abstract

This mixed-methods research study set in a community school in the Midwest will examine how out-of-school time (OST) STEM programs influence students' attitudes toward STEM and the development of 21st century skills over the course of a ten-week program. In this quasi-experimental study, the researcher will focus on a treatment and control group of students. The treatment group will be comprised of 40 first through fifth graders who will participate in STEM after school programs and the control group will include 40 first through fifth graders who will participate in non-STEM after school programs. The study seeks to illuminate the influence of high-quality afterschool academic enrichment programs which serve as core components of the community school framework. Community schools, which are designed to support students, their families, and the community, are unique and under-researched settings. The nature of the setting and the delivery of the programming inform the theoretical framework for the study, which is the bioecological model of development. The aim of the study is to reveal the effects of STEM related OST programs on, (1) student attitudes toward STEM; (2) students' development of 21st century skills; and (3) students', parents', and teachers' perceived outcomes from participation in STEM OST programs. The PEAR Common Instrument Suite and the S-STEM, which evaluate students' attitudes toward STEM and 21st century skills will be used as pre and post assessments in addition to a variety of qualitative measures including teacher interviews, student focus groups, parent focus groups, and program observations using the PEAR Dimensions of Success (DoS) rubric.

Key words: Science, technology, engineering, and mathematics (STEM), out-of-school time (OST) programs, STEM attitudes, 21st century skills

The Effects of STEM Out-of-School Programming on the Development of STEM Attitudes and 21st Century Skills of Community School Students

In a society driven by technology and innovation, careers in the areas of Science, Technology, Engineering, and Mathematics (STEM) are more in demand than ever before (Carnevale, Smith, & Melton, 2011). This demand for future innovative and STEM-trained workers will be met by students in school at this time. In recent years, there has been a national emphasis on the provision of high-quality STEM programming in U.S. schools supported by the 2013 release of the Next Generation Science standards for kindergarten through 12th grade students (McClure et al., 2017). The standards include rigorous science practices, core science ideas, and interdisciplinary connections for classroom instruction (NGSS, 2013).

In addition to core curriculum, offering out-of-school time (OST) programs has become an increasingly popular approach to supporting and extending students' STEM learning (Wilkerson & Haden, 2014). Community schools aim to offer a wide variety of extracurricular academic OST programs (Institute for Educational Leadership, 2017). These programs promote positive attitudes and interest in STEM careers starting with the youngest learners (Lyon, Jafri, & St. Louis, 2012; Popa & Ciascai, 2017). Additionally, students are provided with opportunities to develop *21st century skills*, which include collaboration and teamwork, creativity and imagination, critical thinking, and problem solving skills (Alismail & McGuire, 2015; NGSS, 2013).

One challenge associated with the provision of after school STEM programs is identifying measures of program success related to student outcomes. Since students' grades and test scores are associated with a variety of different variables outside of the program, these measures are not appropriate for determining program success (Wilkerson & Haden, 2014). Survey-based measures of change in student attitudes toward STEM concepts over time are more widely recognized as appropriate measures of the effects of STEM after school programs (Krishnamurthi, Ballard, & Noam, 2014; Malyn-Smith, Cedrone, Na'im, & Supel, 2013; Unfried, Faber, Stanhope, & Wiebe, 2015).

Problem

An analysis of the demographic makeup of STEM professionals reveals a lack of diversity in STEM fields. Minorities, especially Latina females and African American males, are starkly underrepresented in STEM fields (Wright, Ford, & Scott, 2017; Young, Young, & Ford, 2017). National statistics of STEM careers in 2011 show that 70% of jobs are held by Caucasians, 19% Asians, 5% Latinos, and 5% African Americans (Excelencia in Education, 2015; Landivar, 2013). This discrepancy is attributed to lack of availability of high-quality STEM programming in urban schools (Krishnamurthi et al., 2014; Ladson-Billings & Tate, 2008).

The U.S. Department of Education (2015) reports that many underperforming rural and urban schools do not have the capacity (i.e. lack of resources or instructors) to teach STEM courses that will enhance students' understanding of a variety of STEM topics. Only about half of the high schools in the U.S. offer calculus and 63% offer physics courses. In these schools, there is limited availability of algebra, geometry, biology, and chemistry courses. There are not enough instructors to teach the courses in these schools, much less track and encourage students' trajectories through the challenging coursework. Without exposure to high-quality STEM experiences, students cannot develop interest or the dispositions necessary to acquire jobs in innovative fields.

The community school approach to education seeks to equalize the playing field for all students. Community schools promote a comprehensive, three-pronged approach, providing layered supports for students and families (Dryfoos, Quinn, & Barkin, 2005). This triadic approach includes the provision of a high-quality core instructional program, extended OST learning opportunities (including STEM programs), and the removal of barriers to learning and development. Dryfoos et al. (2005) refer to this approach as *the developmental triad for community schools*. These three areas are important parts of the community school approach because they promote a comprehensive set of services for students and their families (National Center for Community Schools, 2011). Community schools seek to fill the void of access to high-quality STEM experiences through the equitable provision of high-quality in-school and OST programs for all students and families.

Although there are a variety of research studies related to after school programs in general, there is a paucity of research that addresses the impact of STEM after school programs in elementary community schools (Brown, 2016; Karp & Maloner, 2013; Sullivan & Bers, 2016; Young, Ortiz, & Young, 2017). Additionally, a significant gap in research exists in the area of STEM OST programming and the effect on students' STEM attitudes and 21st century skills. This study seeks to fill those research gaps.

The implications of the study are especially important for schools interested in adopting the community school framework and/or providing after school STEM programs for students. Procuring funding for high-quality STEM programs can be challenging, as there is often little or no funding built into school budgets for co-curricular programs. The investment of donors and community partners is generally a primary source of funding for after school programs in community schools (National Center for Community Schools, 2011). Research on the impact of OST programs on student attitudes toward STEM and the development of 21st century skills may provide findings that motivate donors and community partners to fund high-quality STEM programs for the elementary school students who will one day be a part of the workforce. Increasing the number of high-quality STEM programs for underrepresented students is a step towards providing equitable opportunities for all students.

Purpose

The purpose of this study is to evaluate the influence of four, ten-week STEM after school programs on the attitudes, perceptions, and the development of 21st century skills of 1st through 5th grade students in a community school. The guiding research questions for this study include the following:

4. For students at a community school, what effect do STEM related OST programs have on their attitudes toward STEM learning?
5. For students at a community school, what effect do STEM related OST programs have on the development of 21st Century Skills?
6. What outcomes do students, parents, and teachers perceive from student participation in STEM related OST programs?

Based on theory and research related to the research questions in this study, the researcher hypothesizes that students' participation in ten-week, high-quality OST STEM programs will positively impact attitudes toward STEM and students' development of 21st century skills. The perceptions of students, parents, and teachers will be helpful in revealing insights about specific gains made in the programs.

Theoretical Framework

The community school setting of the study is a primary influence in the selection of the theoretical framework for this study, which is Bronfenbrenner's bioecological model of human development. Several different factors influence a child's learning and development (Bronfenbrenner & Morris, 2006). When a child is born, she is born into a family with a unique set of characteristics, needs, and values. The family's structure (i.e. single parent vs. two parent) and socioeconomic status, for example, affect the ways in which the family operates and, thus, how the children in that family grow and develop. Bronfenbrenner and Morris (2006) theorize that an individual's development involves four dynamic properties: proximal processes (responsiveness and supportive interactions), people, contexts, and time. The dynamic properties of development call for an equally dynamic and comprehensive approach to education inclusive of, not only the child, but also the child's family and the community. High-quality STEM experiences contribute to a comprehensive and supportive approach to education (McClure et al., 2017). *Community schools* support child development and the wellbeing of the family through the provision of layered resources (Quinn, 2005).

An earlier version of Bronfenbrenner's theory, the ecological systems theory, proposes that there are multiple contextual levels that influence a child's development (Bronfenbrenner, 1979). These contexts include the microsystem, mesosystem, exosystem, and macrosystem. The closest context to a student is her *microsystem*, which includes the physical home environment, family, friends, school, and peer group (Bronfenbrenner, 1977). Individuals and settings in the microsystem directly influence the student. The microsystem is nested in the *mesosystem*, which is comprised of the interactions between the different elements of the microsystem (i.e. how the values of the peer group compare to the values of the family and the tensions that result from those differences). Miller (2016), citing Bronfenbrenner (1977), describes the mesosystem as "a system of microsystems," (p. 189). Like the mesosystem, the *exosystem* includes the interactions of two different settings, one of which does not have a direct influence on the child (Bronfenbrenner, 1979). An example of the exosystem is a child's home life and the interaction with her parent's work environment. Parents who experience stress at work may express frustration at home, exemplifying how two very different settings interact and influence the family. The final context and outermost concentric contextual ring is the *macrosystem*. The macrosystem consists of cultural norms, ideologies, and priorities that have emerged due to the interactions of all the sub-systems (micro-, meso-, and exosystems) in a given population. One final element of the ecological system is the chronosystem, which is the influence of time in creating patterns and paradigms in various cultures (Bronfenbrenner & Morris, 29006).

Community schools provide targeted supports at the microsystem (family unit) and the mesosystem (community) levels. At the microsystem level, if the family is loving, well resourced, and functions harmoniously, the child's development will progress normally. However, if a family is dysfunctional, lacking basic needs, and/or there are frequent exposures to trauma, the child's development will be negatively influenced. A child's mesosystem is her community. As mentioned previously, the condition of the community (mesosystem) and the interactions within that system influence a child's development just as the microsystem (family) influences development.

The purpose of community schools is to support family units while also empowering and uniting the community around high-quality education for all students.

Review of Literature

Community schools offer a unique approach to public education (Dryfoos et al., 2005). Understanding the community school framework reveals how the whole-child, whole family approach works in supporting student growth, retention, and achievement. One of the primary areas of focus in community schools is providing high-quality curricular and OST programs for *all* students, which promotes equal access and opportunity for all. The following literature review defines the community school framework including OST programs, discusses how 21st century skills and STEM attitudes influence students' interests and motivations to pursue STEM in the future, and explains the components of high-quality STEM instruction.

Community School Framework

The African proverb "It takes a village to raise a child," captures the essence of the community school philosophy. The mission of community schools is to build strong communities by meeting the needs of students and families and facilitating connections among the school, families, and community members (Block, 2009; Kretzmann & McKnight, 1993). These processes occur through the provision of a strong core instructional program, out-of-school enrichment programs, and the removal of barriers to learning (Dryfoos et al., 2005). Community school educators seek to establish and build up connected and well-educated communities comprised of engaged families who understand and prioritize the importance of child development and high-quality education.

The purpose of community schools is to make education universal *and* equitable for all students (Rogers, 1998). Eliminating or combatting barriers that hinder schooling (i.e. medical needs, food insecurity, poverty, language barriers, etc.) is a critical first step in promoting the equitable access for all students (Dryfoos et al., 2005). Community school coordinators partner with outside organizations to connect families with a variety of resources to meet both basic and complex needs.

In 2012, Castrechini and London, in conjunction with the Center for American Progress, evaluated the outcomes of students in California community schools situated in areas of high poverty. Student and family engagement survey responses and student academic scores (specifically language outcomes) were used to evaluate program success. The researchers found that in the focus schools, student language outcomes (especially those of English learners [ELs]) showed consistent gains over time. This finding was particularly important as 89% of the students in the schools were not native English speakers and research shows that language acquisition precedes success in other areas of academic success (Krashen & Terrell, 1983; Sousa, 2011). Interestingly, these language outcomes were significantly linked to family engagement and participation (Castrechini & London, 2012). Over 70% of students and families in these schools participated in OST programs provided by the school. Students and families who participated in these programs reported having positive attitudes about school.

Castrechini and London's (2012) findings highlight the importance of community schools in promoting family engagement and student success. Additionally, the findings from the study illuminate the important connection between the family's involvement in their child's schooling and the child's success in school. Engaging and supporting the entire family is an important part of educating the child (McClure et al., 2017). Though there is existent research on family involvement and positive student outcomes related to the community school approach, there is very little research on the impact of after school enrichment programs, especially STEM programs within the community school context. This study will contribute to the community school literature in the area of STEM OST enrichment opportunities.

OST programs. A host of challenges and barriers to education exist for low-income families. In some cases, parents work long hours at multiple jobs and require summertime, holiday, before, and after school childcare so that they can earn incomes to support their families (National Center for Community Schools, 2011). Community schools provide high-quality OST learning opportunities for students outside of the regular school hours. For families who cannot afford costly programs like extracurricular sports, arts, or science programs, these resources are invaluable. They provide students with a safe place to go outside of school hours, chances to collaborate with peers in team settings, and opportunities for new learning and experiences (Dryfoos et al., 2005).

Community partnerships are the lifeblood of any community school since providing OST learning opportunities is a costly endeavor that many schools cannot afford (Dryfoos et al., 2005). A community school may establish partnerships with outside organizations like community businesses, non-profits, or faith-based groups and invite them to come into the school to provide after school programming for students. Other examples of extracurricular clubs hosted by community partners include sports and activities clubs; Science, Technology, Engineering, and Math (STEM)-related clubs sponsored by STEM-focused community organizations; and clubs sponsored by community health departments. These extracurricular opportunities provide students with high-quality, no-cost programming without having to leave the safety of the community school building.

Program evaluation. Program evaluation is important in ensuring that an OST program is achieving the goals that it sets out to achieve (Patton, 2012). Goals set at the beginning of programming should be SMART (specific, measurable, achievable, relevant, and time bound) in nature and guide the program implementation from start to finish. Periodic observations help to ensure that the program stays goal-oriented and does not drift from the program goals. Ensuring that program goals are outcome-focused is important, as goals can sometimes be too broad, ambitious, or unmeasurable. For this reason, discussing goals at the onset of programming enables program providers and evaluators to have a common understanding of the student outcomes that should be achieved by the end of programming as well as the program activities that support those outcomes.

Attitudes Toward STEM

A prominent metaphor to describe students' attitudes and participation in STEM subjects is the STEM *pipeline* (Lyon et al., 2012). This pipeline begins in early childhood as students become interested in problem solving and engaging with the world around them. Those who are provided with continued experiences to experiment and explore in STEM areas are likely to seek other opportunities to continue their exploration. The more experience and practice students have working with STEM content, the more motivated and engaged they become in STEM learning. By middle school, the years in which students have more decision-making power about the courses that they take, students need to have developed an interest in STEM or they risk exiting the STEM pipeline. Parents and teachers can support positive attitudes toward STEM through their encouragement, positive messaging, and the provision of frequent opportunities to engage in inquiry and explorative learning.

Student attitudes toward STEM. Unfried et al. (2015) define STEM attitudes in terms of self-efficacy and expectancy-value beliefs. Self-efficacy is the perception of influence that an individual has over her situation (Bandura, 1986). High self-efficacy occurs when a person feels that she has the capability to accomplish a goal, win a game, or create a masterpiece. High self-efficacy is associated with positive academic outcomes especially in the areas of math and science (Scott & Mallinckrodt, 2005; Wang, 2013). The second component implicit in STEM attitudes is expectancy-value beliefs. Expectancy-value beliefs are connected to goal-setting potentials. Those with high expectancy-value understand the steps necessary to achieve their goals. They modify their behaviors to maximize the likelihood of goal attainment (Eccles & Wingfield, 2002). Expectancy-value beliefs are associated with long-term academic persistence (Fan, 2011). This two-pronged conception of STEM attitude provides an important outcome to measure in the provision of OST STEM programs. In terms of future involvement and commitment to STEM careers, this attitudinal outcome is a much more powerful indicator of program success than student academic scores, which are susceptible to many outside influences (Wilkerson & Haden, 2014).

Parent and teacher attitudes toward STEM. Relationships with supportive caregivers enhance students' learning (Lyon et al., 2012). Parents and teachers who are passionate about helping their children become interested in STEM speak positively about STEM activities and they encourage children to think critically, problem solve, and engage in opportunities that will expand their 21st century skills (McClure et al., 2017). Teachers and parents also serve as models for their students, demonstrating the ways that STEM can be used on a regular basis to meet a variety of needs. Through positivity, modeling, and encouragement, parents support the formation of positive STEM attitudes and self-efficacy related to STEM tasks.

Bandura defines self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 31). A child can have a thousand different skillsets, but each of them is useless if there is not the belief that those skills can be used to accomplish goals or achieve certain outcomes. Students with high self-efficacy know that they have the capacity and ability to achieve their goals. Students develop self-efficacy as they successfully accomplish new and previously difficult tasks and as they observe the success or failure of their peers attempting new tasks (Bandura, 2006). Opportunities to try, fail, and succeed are important for self-efficacy development and are supported both at home and in the classroom.

When students persist through failures and eventually reach success, their beliefs about their own self-efficacy are bolstered (Unfried et al., 2015). Learning experiences that involve persistence, collaboration, and problem solving can support the development of self-efficacy beliefs. Additionally, self-efficacy can be supported by trusted others (parents and teachers) who encourage a child that she can achieve a desired outcome (Bandura, 1997). In the classroom, this adult and peer support is critical in fostering a collective sense of self-efficacy.

21st Century Skills

Over the past decade, 21st century skills have become a primary focus of policy makers, educators, and professionals in STEM fields (National Research Council, 2010; Partnership for 21st Century Skills [P21], 2004; PCAST, 2010). 21st century skills include a set of dispositions and outcomes that promote students' long-term interest and participation in STEM fields and careers (Unfried et al., 2015). These skills include creativity, innovation, critical thinking, problem solving, communication, collaboration, environmental literacy, and self-management skills (P21, 2004). All the aforementioned skills are considered necessary for success in innovative 21st century professions. The change in students' perceived development of 21st century skills over the span of the study will serve as a second STEM OST program outcome in addition to changes in attitudes toward STEM.

STEM Standards

In 2013, the National Next Generation Science Standards were developed as a collaboration between the National Research Council, the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve (NGSS, 2013). The release of the standards was a product of a national emphasis on STEM preparation for students. The standards, which were developed for K-12 students in accepting states, present science concepts in three of the following dimensions: practices of scientists and engineers, disciplinary core ideas, and crosscutting concepts. Each standard includes a performance expectation that integrates the three science dimensions. Performance expectations are organized in four science domains of physical; life; earth and space science; as well as engineering, technology, and applications of science. The NGSS standards are considerate of all domains of STEM, even though they are identified predominantly as Science standards. The standards, which serve as instructional guides for curriculum during the school day, inform the development of high-quality OST program STEM sessions.

STEM Instruction

Effective STEM instruction is problem-based, interdisciplinary, multidisciplinary, and transdisciplinary (Popa & Ciascai, 2017). Learning emerges when a child employs his knowledge in each of the STEM areas to solve problems. For example, when faced with the task of using a collection of materials to build a Rube Goldberg machine, a second grader will have to use what he knows of engineering design, the science related to gravity and motion, the geometric properties and measurement of angles and timing, and the language required to communicate her plans to her classmates and teacher. Effective STEM instruction is rooted in familiar contexts and tied to concrete experiences so that young students can access the concepts as they engage in the inquiry process (Charlesworth & Lind, 2010).

Research and theory reveal that students learn more when they construct learning on their own through *inquiry* (Dewey, 1938; Piaget & Inhelder, 1969; Rissanen, 2014; Wood, 2007). This type of explorative learning is a foundational approach associated with the constructivist paradigm of early education. Students who are given the autonomy to explore and investigate STEM concepts within a safely structured environment will develop a deep understanding of these concepts and their real world applications. The following sections explore how students acquire knowledge in each of the STEM domains as well as effective teaching practices for supporting this knowledge.

Scientific reasoning. Scientific reasoning involves *domain-general cognitive processes* in combination with *domain-specific knowledge* (Fugelsang & Mareschal, 2013). That is, the process of engaging in science learning is both procedural and informational. For example, to conduct an experiment on how light impacts the growth of a planted lima bean, students must possess knowledge about basic plant needs. In addition to this plant-specific knowledge, students should be able to develop a hypothesis and an organized method for testing that hypothesis. The domain-general cognitive processes are closely related to 21st century skills. These skills include helpful dispositions for experimentation and problem solving (Unfried et al., 2015).

Inquiry-based learning promotes the development of domain-specific knowledge and domain-general processes (Charlesworth & Lind, 2010). Beginning a lesson with a problem or question and providing students with an opportunity to think as scientists and develop a plan for finding the answer encourages the growth of domain-general processes (Bruner, 1966). As students test their hypotheses and seek to find answers about the world around them, teachers can build on this knowledge through instruction tailored to students' place in the inquiry process. Science learning must be encountered through experiences. Rote learning of detached science facts is not only ineffective, it robs students of opportunities to develop domain-general, problem-solving skills (Charlesworth & Lind, 2010).

Technology skills. The "T" for Technology is the STEM component often omitted from classroom instruction in early education (Donohue, 2017; Sullivan & Bers, 2015). The reasons for its omission are rooted in the assumption that technology is inaccessible and excessively challenging for young students to understand (Highfield, 2015). Research shows that this assumption is inaccurate. Studies of Pre-K through 2nd grade robotics programs reveal that kindergarten through 2nd grade students are not only able to understand the foundations of robotic technology and programming, they enjoy the process of building and programming them (Sullivan & Bers, 2016; Highfield, 2015). Not only are students competent to solve problems using technology, they are eager to explore and engage in the process. Technology is interdisciplinary and can be easily integrated into all areas of instruction (McClure et al., 2017). Technology literacy begins at an early age with the messages that teachers and caregivers send to students about technology use. Donohue (2017) recommends that teachers demonstrate and promote responsible technology use when they are with students and their families, sharing ideas about internet safety, technology use in moderation, and effective ways to support learning with technology.

Engineering experiences. A visit to any constructivist early childhood classroom reveals just how natural it is for students to engage in engineering processes. Block play and construction are foundational tasks that encourage young students to adopt the mindset and purposes of engineers (Van Meeteren & Zan, 2010). Through construction experiences, students learn how to collaboratively design and modify a structure that fulfills their purposes. The Committee on K-12 Engineering and Education assert that engineering activities promote 21st century "habits of mind" including systems thinking, creativity, optimism, collaboration, communication, and attention to ethical considerations (Katehi et al., 2009, p.152).

Mathematics instruction. As young students grow, they develop capabilities for understanding increasingly complex math concepts (Kamii & Housman, 2000).

Foundational to mathematical understanding is the ability to make connections and build mental relationships between objects and concepts. Piaget and Inhelder (1969) refer to this type of reasoning as logico-mathematical reasoning. As students build logico-mathematical connections, their understandings of quantity, number, sequence, grouping, classification, and conservation grow and they can apply their mathematical understanding to solve problems (Van de Walle et al., 2018).

The National Association for the Education of Young Children (NAEYC, 2002) recommends that teachers weave mathematical reasoning into all parts of the school day rather than presenting math as an isolated concept. For example, teachers can encourage students to engage in math as they pass out materials for a project. The teacher may provide thirty pieces of construction paper for a class of 24 students. She might ask the class how many pieces of paper will be left over after all the pieces are passed out (Kamii & Housman, 2000). These types of naturally occurring math conversations encourage students to make math connections throughout the day. The natural integration of mathematics into the daily routine supports young students' math understanding. Additionally, it builds their interests in using math as a problem solving tool.

In reviewing the literature about the components of STEM in the early childhood classroom, an important theme emerges. STEM components and concepts should not be taught in isolation (McClure et al., 2017). Attempting to teach concepts about science separately from concepts about mathematics, engineering, and technology may result in dry, disjointed, and de-contextualized learning (Van Meeteren & Zan, 2010). Instead, STEM concepts should be presented to students through inquiry and problem-based learning, which authentically opens up opportunities for students to explore all STEM components.

Theory of Change

Grounding a research methodology in a theory of change model helps to not only promote the purity and logic of methodological design, it also helps to explain the processes and outcomes that occur throughout the course of a study (Knowlton & Phillips, 2009). The theory of change in this study reflects the theoretical framework of the study, the bioecological model of development. The theory of change, presented as a logic model, shapes the researchers' hypothesis for the study- that the participation in high-quality OST STEM programs will have a positive impact on the STEM attitudes and 21st century skills of students in a community school. This will hopefully lead to students' continued interest in STEM and openness in pursuing STEM opportunities later in their school careers.

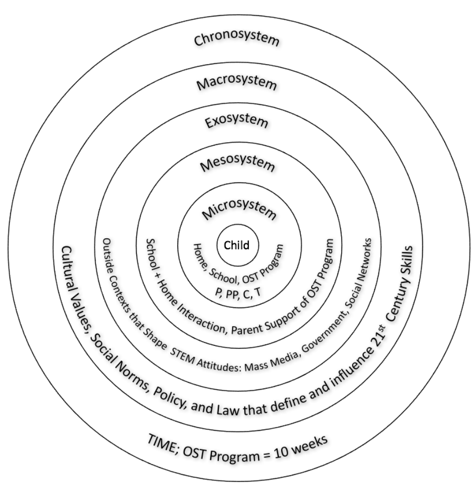

Figure 1. STEM and OST programs explained through ecological systems theory.

When students are exposed to positive STEM messages and influences at every contextual level, they are predisposed to developing a positive affect toward STEM activities and content (McClure et al., 2017). Figure 1 depicts the widely used concentric circle model to connect the ecological systems theory and the development of positive STEM attitudes and 21st century skills. Parents and teachers who convey positive attitudes toward STEM at the microsystem level positively influence students' perceptions of STEM. McClure et al. (2017) refer to parents and the home as "the gateways to STEM" (p. 20) and explain that parents who support STEM learning at home help to build self-efficacy toward STEM while also averting occurrences of math anxiety or negative dispositions toward STEM and problem solving. Students who are able to engage in positive STEM experiences with their friends at home and school (the mesosystem level), and whose parents are engaged in their school lives are naturally exposed to frequent and varied experiences that will capture their interests.

Though the exosystem and macrosystem levels are more contextually distal in relation the child, they are still important influences on STEM education. McClure et al. (2017) explain that research and policy strongly influence STEM education at the exosystem level. Advocacy for equitable and high-quality STEM is a critical step in promoting diversity in STEM professions. Finally, working to shift cultural and social paradigms to prioritize high-quality curricular and co-curricular educational programs for all students (including equal access to STEM opportunities) promotes STEM at the macrosystem level.

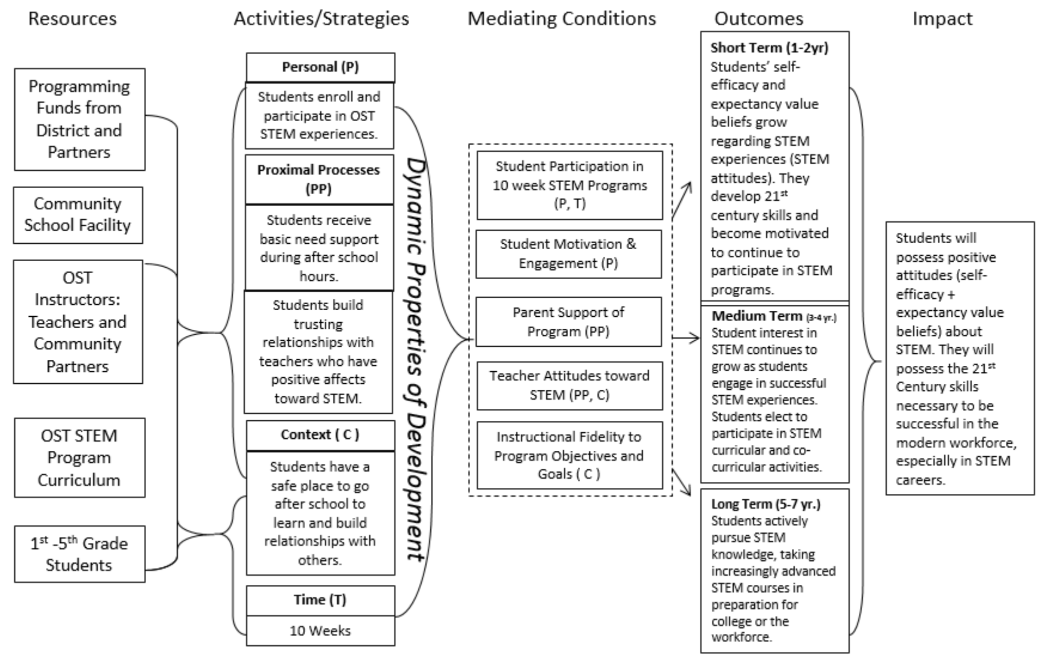

Figure 2. STEM OST program logic model

A STEM OST program logic model serves to explain the theory of change for this study (Knowlton & Phillips, 2013). The theory of change, shown in Figure 2, identifies the resources in place at the focus community school. These resources include a community school facility with instructors and STEM professionals who are interested in working with first through fifth grade students. Importantly, high-quality OST STEM instruction is an important resource accessible to all teachers. Additionally, the school benefits from having the funding support and resources from district and community partners to provide the OST programs.

The activities and strategies that contribute to student outcomes incorporate the four defining properties of the bioecological model, which include personal characteristics, proximal processes, context, and time (Bronfenbrenner & Morris, 2006). Participation in an OST program involves a personal decision between the child and the family. Together, the parents and child must take the steps necessary to enroll the child in the club (i.e. completing the enrollment form). Once the child has been accepted and placed into an OST program, she is provided with proximal process and context supports. Proximal processes that support the development of positive STEM attitudes include the development of trusting relationships with an OST teacher who conveys positive messages about STEM and provides support for the student during the after school hours. Contextual supports include the provision of high-quality STEM instruction in a safe place where relationships with others can be built. Another important bioecological property that influences the development of STEM attitudes and 21st century skills is time. Over the course of ten weeks, students will have time and opportunity to engage in STEM learning with others, participate in experiments and problem solving activities, and receive a variety of supports that may help to positively shape attitudes toward STEM.

The mediating conditions in the study include student attendance and participation over the course of the 10-week program, students' levels of motivation and engagement, amount of parent support of the program, teachers' expressed attitudes toward STEM, and the instructional fidelity to the program objectives and goals. Each of these mediators links back to the bioecological properties, as indicated by the abbreviations in Figure 2. The short-term outcomes that will be evaluated in this study include community school students' improved attitudes toward STEM as well as the development of 21st century skills. Also important, though not directly evaluated in this study, are the medium-term outcomes, which include students' motivation to continue participating in STEM opportunities throughout their school careers. Long-term outcomes include students' openness to pursuing STEM opportunities later in life as they become a part of the 21st century workforce.

Methodology

To gain a holistic understanding of all the factors that contribute to students' STEM learning and attitudes during the course of a ten-week after school STEM program, both quantitative and qualitative measures of student outcomes are needed (Merriam & Tisdell, 2016; Mertens, 2015). This study will be a convergent mixed methods study, defined by its quasi-experimental design with one treatment and one control group.

Research Design

Both qualitative and quantitative forms of research present complexities inherent in the data that they yield (Merriam & Tisdell, 2016). Survey, focus group, interview, and observation data will be collected simultaneously throughout the study, contributing to the study's convergent design (Mertens, 2015). The beauty of mixed methods research is that data derived from both approaches contribute to a comprehensive explanation of the study's results. The data and analysis of both qualitative and quantitative data types will be collected, analyzed, and triangulated to explain the influence of STEM after school programs on students' attitudes toward STEM, the development of 21st century skills, and learning outcomes achieved over the course of the study.

Participants

Treatment group. For this study, the population of interest is a convenience sample (Miles, Huberman, & Saldana, 2014) of first through fifth grade students (ages 6-10) at a Title I community school with a high (66%) Latino population, and with 96% of students in the school receiving free or reduced lunch. Ten different native languages are represented within the student population. In the 17-18 school year, 53% of the 860 students were involved in at least one of 20 after school programs offered four days per week (Monday through Thursday), each semester (348 students in the fall, 450 in the spring).

Participants in the treatment group will include those students who enroll in STEM programs, or clubs, and receive parent permission to stay after school for programming. Entry into these programs is done in the order that student enrollment forms are received, based on the school's OST placement protocol (first-come-first-served basis). Once the club has reached its capacity (10-20 depending on the program), students who have signed up for the club are then enrolled in their second or third choice programs and they are added to a wait list for the following semester's enrollment.

The treatment group is a convenience sample of approximately 85 students participating in one of six, ten-week STEM after school programs. The optional programs include a STEM and Art club for 1st through 3rd grade students led by the local museum, a teacher-led STEM Builders Club (1st- 3rd grade), a teacher-led Coding club (1st – 3rd grade), a teacher-led Robotics Club (4th -5th), a teacher-led Coding club (4th-5th grade) and a partner led Chess and Computer Programming club (4th -5th) taught by a community technology partner. 35 first through third grade and 40 fourth through fifth grade students will be included in the treatment group. It is important to note that the sample size may fluctuate slightly from the predicted number due to variations in program attendance caps (i.e. the cap for Robotics is 10 and the cap for Chemistry is 15).

Control group. The control group in this study will be comprised of approximately 91 students who tried to enroll in STEM clubs but were waitlisted for a STEM club the following semester and placed in their second choice, a non-STEM program. The primary criteria for the control group is that they must have attempted to enroll in a STEM club but are placed in a non-STEM club because of filled capacity. This will ensure that students from both the treatment and control groups have similar interests and parent support regarding STEM OST programs. The non-STEM clubs will include Reader's Theater (1^{st}-3^{rd}), Camp Fire (1^{st} – 3^{rd}), Reading Club (1^{st}-3^{rd}), Soccer (4^{th}-5^{th}), Running Club (4^{th}-5^{th}) and Camp Fire (4^{th} -5^{th}). At least 39 students from first and second grades and 52 students in third through fifth grades will be included in the control group. The first ~45 first through third graders and the first ~45 fourth through fifth graders who meet the aforementioned criteria during the enrollment window will be added to the control group. Similar to the treatment group, the sample size of the control group may fluctuate slightly from the predicted number because of variations in enrollment maximums for each program (i.e. the cap for Campfire is 12 and the cap for reader's theater is 10).

Student recruitment. Before the study will take place, the researcher will meet with the school district to acquire district consent and endorsement of the study. During that meeting, the researcher will gain approval for parent consent and student assent forms (two versions- English and Spanish). Once district approval is granted, parent and student consent forms providing information about the study and the choice to "opt out" of the study will be sent home with all OST program enrollment forms. Sending home consent forms with all enrollment forms is a practice already in place at the school since the school has implemented the PEAR CIS (which includes a consent/opt-out form) in previous semesters. Sending home consent forms with all students will ensure that parents and students understand that they may be a part of a study and that they can choose to opt out of the study if they would like. Those who choose to opt out of the study will not be prevented from participation in STEM programs. Their information will be excluded from the study.

Teachers. All programs at the community school are funded by grants and donations from community partners. Pre-K through 5th grade teachers, teaching assistants, and paraprofessionals at the school who are hired to teach after school programs are paid hourly for their planning and teaching time and apply for the position before the start of each semester. The costs of OST programs taught by the children's museum and Campfire are also covered by community grants and partnerships. The study will help the school by providing program evaluation information for programs funded by community partners. All OST programs at the school (even those not included in the study) include the PEAR CIS and DoS evaluations as a part of annual program evaluation, thus, many teachers will already be familiar with the measure. Outside educators from the children's museum and Campfire (non-STEM program) will be included in the study. Communication about the study with the respective organizations will take place before the start of the semester's programming. The researcher will receive verbal and written consent from both partner groups to include the programs as a part of the study.

Before the beginning of the study, the researcher will hold a meeting with OST program teachers and partner educators about the purpose and details of the study as well as the level of involvement required for participation in the study. After the informational session about the study, teachers will be able to make final decisions about which programs that they would like to teach. Those who will be teaching OST programs included in the study will provide consent for participation in the study and schedule interviews for the final weeks of programming. The six STEM clubs that will be included in the study will be Coding for Kids (1st – 3^{rd}), STEM and Art (1st – 3^{rd}), STEM Builders club (1^{st}-3^{rd}), Robotics (4^{th}- 5^{th}), Coding (4^{th}-5^{th}), and Chess and Computer Programming (4^{th}- 5^{th}). The non-STEM clubs include Reader's Theater (1st – 3^{rd}), Campfire (1st – 3^{rd}), Artistic Expression (1^{st} – 3^{rd}), Running Club (4^{th}- 5^{th}), Camp Fire (4^{th}-5^{th}) and Soccer (4^{th}-5^{th}).

Parents. Parents of students in 1^{st} through 5^{th} grade who enroll their children in STEM or non-STEM OST treatment and control programs will be invited to participate in one of four focus groups included in the study. The focus groups, which will include 1^{st} – 3^{rd} control, 1^{st} -3^{rd} treatment, 4^{th}-5^{th} control, and 4^{th}-5^{th} treatment, will take place during the eighth and ninth weeks of programming. Recruitment efforts will include hard copy and digital invitations in English and Spanish distributed via e mail and shared with students to give to their parents. Phone calls in English and Spanish as well as in person communication at arrival and dismissal times will also be helpful in recruiting parents to attend a focus group.

Setting

The community school where the study will take place is part of a public school district in the Midwest. The school has an extensive group of community partners who provide programming and resources for over 42 free after school programs for students.

Of those programs, 29 are STEM related programs including Robotics, Chemistry, Gardening, Physics, Connect Block Architecture, and Math club.

STEM OST program planning and curriculum design. Four of the six STEM programs in this study will be teacher-led and developed (funded by community partners) and the other two programs will be planned and taught by the children's museum and computer and technology store in the community. Including the two different types of programs (teacher-led and partner-led) will help to reveal if there are differences in student outcomes by program type. All programs will take place in classrooms at the elementary school. Many of the STEM clubs will take place in the school's *Tinker Lab* because the room is outfitted with necessary access to sinks and protective equipment. Similarly, two of the six non-STEM programs will be taught by outside partners (Campfire) and will take place in the art room and gymnasium respectively.

The partner-led STEM programs will use the 5E method of STEM instruction. The instructors of the teacher-led programs will also be provided with 5E lesson plan resources, though the use of the method will not be required. The five Es in the 5E model stand for engage, explore, explain, elaborate, and evaluate (Orgill & Thomas, 2007). In the 5E model, teachers engage their students with a problem to be solved. Students are then encouraged to explore the components and variables of the problem in order to gain insight into how the problem may be solved. At this point in the process, teachers step in and deliver the explanations and concepts related to the problem. Once students have cultivated a thorough understanding of the problem and its related concepts, teachers present the students with a challenge to elaborate on the problem by building a model, explaining a solution, or creating an analogy related to the problem. Throughout the entire process, the instructor is evaluating a number of different student activities and behaviors including how the students decide to solve the problem, the types of questions and roadblocks that emerge, and the level of conversation that students are able to participate in during the problem solving experiment (Orgill & Thomas, 2007).

STEM OST program evaluation. A goals-based evaluation will be implemented to gauge the success of the STEM OST programs (Patton, 2012). The teachers and community partners will develop a hard copy list of program goals which will include growth in the two measures of STEM attitudes and the development of 21^{st} Century Skills. The goals will be specific, measurable, achievable, relevant, and time bound (SMART) and will be shared and discussed with the researcher before the start of programs. Once appropriate program goals have been defined, periodic observations will take place during weeks three, six, and eight of programming to evaluate activities that support those goals. The Partnerships in Education and Resilience Dimensions of Success (PEAR DoS) rubric and the SMART program goals will be used to guide the observation.

Treatment and Dosage

The treatment in this quasi-experimental study will be the provision of STEM after school program instruction for first through fifth grade students (Mertens, 2015). There will be six treatment programs in the study, three programs for 1^{st} through 3^{rd} grades (Coding for Kids, STEM and Art, and STEM Builders Club) and three programs for 4^{th} – 5^{th} grades (Robotics, Chess and Computer Programming, and Coding; see table 1). Program sessions occur weekly for ten weeks with eight sessions designated solely for instruction and two sessions- one at the beginning and one at the end of programming-designated for pre and post data collection. For every program in the treatment group of the study, there is a similar control group, as noted in table 1.

Table 1

Types of OST programs with teacher type, grade level, cap, and dosage

Treatment or Control (T/C)	Program	Teacher Type	Grade Level	Cap # students	Number of days per week
T	Coding for Kids	Teacher	1-3	15	2
T	STEM and Art	Community Partner	1-3	15	1
T	STEM Builders Club	Teacher	1-3	15	1
T	Robotics	Teacher	4-5	10	2
T	Chess & Computer Programming	Community Partner	4-5	15	1
T	Coding	Teacher	4-5	15	1
C	Readers Theater	Teacher	1-3	12	2
C	Camp Fire Starflight	Community Partner	1-3	12	1
C	Rocket Readers	Teacher	1-3	15	1
C	Soccer	Teacher	4-5	20	2
C	Camp Fire Adventure	Community	4-5	12	1
C	Running Club	Partner & Teacher	4-5	20	1

The reason for having a pre and post program session is so that program time of the eight instructional sessions can be fully devoted to instruction rather than survey completion. The age groupings (1^{st} through 3^{rd} and 4^{th} through 5th) are pre-determined by the outside programs. To maintain consistency, the teacher-led groups will be divided in the same way. Program sessions will take place for 1.5 hours once per week for ten consecutive weeks. During the pre and post data collection sessions, students will have access to program-related STEM centers and activities that they can work on collaboratively before and after they take their surveys and participate in focus groups.

In all programs (treatment and control), children will be provided with a snack from the district's child nutrition services department during the first fifteen minutes of every program session in order to curb their hunger after the school day.

Data Sources and Collection Procedures

The following research questions will serve to guide the research:

1. For students at a community school, what effect do STEM related OST programs have on their attitudes toward STEM learning?
2. For students at a community school, what effect do STEM related OST programs have on the development of 21st Century Skills?
3. What outcomes do students, parents, and teachers perceive from student participation in STEM related OST programs?

A variety of qualitative approaches including teacher interviews, parent focus groups, student focus groups, and observations of the program sessions will be utilized to answer question three.

Quantitative Data and Procedures

The sources of quantitative data in this study, used to answer questions one and two, will be the pre- and post- PEAR Common Instrument Suite (CIS) surveys and S-STEM standardized and adapted surveys of student STEM attitudes and 21st century skills (Friday Institute for Education Innovation, 2012; PEAR Institute, 2017a). They will be presented together in digital form. The administration details are enumerated in the following sections.

PEAR CIS. The PEAR CIS (omitted from this document, per PEAR's confidentiality guidelines) is a survey designed to measure STEM-related attitudes, interest levels, knowledge about STEM careers, and STEM identity (PEAR Institute, 2017a). The survey was developed with OST programs in mind and is intended for program evaluation use (PEAR Institute, 2016). Each survey question includes a 5-item

Likert scale. The survey has two outcome categories: STEM-Related Attitudes and 21st century skills/socio-emotional learning (SEL). The subcategories in the STEM-Related Attitudes section include STEM interest, identity, career interest, career knowledge, enjoyment, and activities. The subcategories of the 21st century skills/SEL section include relationships with adults and peers, perseverance, and critical thinking. Three age-appropriate versions have been developed for K-3rd grades, 4th-5th grades, and 6th-12th grades. The K-3rd grade version includes 15 items and the 4th-5th grade version includes 37 items. Both the K-3rd and 4th-5th versions (the versions that will be used in this study) include demographic information sections.

The CIS can either be delivered in a hard copy, paper version, or an online version intended to be taken using a tablet. The survey is internally consistent with Cronbach's alpha values greater than 0.85 for all sections. CIS administration takes approximately 10 minutes to complete. Three delivery methods of the survey are available and include the traditional pre-test/post-test, retrospective pre-post, and retrospective change versions. The version that will be used for this study is the traditional pre-test/post-test version.

S-STEM 21st century skill survey. The S-STEM is a four-part standardized survey of student attitudes and dispositions toward each category of STEM, as well as perceptions of their development of 21st century skills over the course of the program (Friday Institute for Education Innovation, 2012). For this study, only the 21st century skills section will be used. Even though the PEAR CIS includes measures of 21st century skills, the S-STEM includes a more comprehensive set of questions about a variety of 21st century skills.

The S-STEM survey includes a 5-item Likert scale for each of the 11 questions (Friday Institute, 2012). The survey will be administered along with the PEAR CIS as a pre- and post- survey to all students in the control and treatment groups at the beginning of programming and again during the final session of the ten-week program. The S-STEM survey is a paper-based survey initially developed for upper elementary grades (4th and 5th). It is internally consistent with a relatively high Cronbach's alpha of .86 for the Math dispositions section, .84 for Science dispositions, .84 for Engineering and Technology dispositions, and .86 for 21st Century Learning Attitudes (Friday Institute, 2012).

Adapted survey of 21st century skills for 1st -3rd grade students. The S-STEM was designed for 4th and 5th grade students (Friday Institute, 2012). For this reason, the measure will be adapted for appropriateness for 1st through 3rd grade students who may have trouble reading, understanding, and completing the survey. These adaptations include the simplification of wording in the S-STEM items, the verbal administration of the survey, the reduction of the 5-item Likert to a 2-item "yes" or "no" selection, and the inclusion of emotion faces with both options. These are appropriate adaptations for assessment of young children (Mellor & Moore, 2013).

Survey administration. OST program teachers will administer the survey to their students. All teachers will participate in training about how to administer the survey to their students during an OST staff meeting before the start of programming. Questions about survey administration will be answered during the staff meeting. The PEAR CIS and S-STEM surveys will be input into a Qualtrics digital format so that all students can use an electronic tablet to answer their surveys one item at a time. Taking the survey digitally with one item displayed at a time helps students to maintain focus on each item without looking forward to other items or rushing to complete the survey (Tzuriel, 2001). For 4th and 5th grade students, the measures will remain in their exact original forms, with the only differences being that the format will be digital, and questions will be presented one at a time. Surveys will be administered verbally and digitally to students in 1st through 3rd grades.

The digital format of the surveys will not only help students take the time that they need to answer each question, it will also help create a seamless transition between data collection, entry, and analysis. When students from the control and treatment groups take the Qualtrics digital surveys at the beginning and the end of the study, the data will be imported into the Statistical Package for the Social Science (SPSS). It will be necessary to thoroughly examine the data set to identify and adjust for missing data before running analyses (McCormick, Salcedo, & Poh, 2015). The analyses with complete data sets will reveal significant differences or similarities among the control and treatment groups.

Qualitative Data and Procedures

Teacher interviews. Before programming begins, each teacher in the treatment and control groups will provide a hard copy list of program goals, session plans, and objectives for their program. At the end of the study (week 9 or 10), semi-structured interviews will be conducted with all twelve of the teachers in the treatment and control groups (Merriam & Tisdell, 2015). The interviews will include questions about student learning and growth over the course of the program (Appendix C). Questions about the types of activities implemented throughout the program to meet the program goals will also be posed. Finally, questions about how students' new knowledge and skills will transfer into other areas of their lives will reveal the teachers' views of student outcomes over the course of the program, addressing the third research question in the study. The interviews, which will last approximately 45-60 minutes per teacher will be recorded on a portable recording device, transcribed, and analyzed for trends and themes. Interview protocol is included in Appendix C.

Parent focus groups. Parent perceptions of students' participation in OST programs and STEM learning will be elicited during four different focus group sessions. Morgan (2013) recommends that focus groups should involve a homogeneous group of six to ten participants who engage in a structured interview with "high moderator involvement," (p. 5). Three to five groups are the recommended number of focus groups for a project. This research study is considerate of each of these recommendations. Six to ten parents who have all enrolled their children in OST programs will be invited to one of four focus groups facilitated by the researcher. Parents of 1st through 3^{rd} grade students in the STEM OST group will be invited to the first session, parents of 1^{st} through 3^{rd} grade students in the control OST group will be invited to the second session, parents of 4^{th} through 5^{th} grade students in the STEM OST group will be invited to the third session, and parents of 4^{th} through 5th grade students in the control OST group will be invited to the fourth session. The purpose of hosting focus groups with parents of students in both control and treatment groups will be helpful in identifying different outcomes between the two groups. The 1^{st} through 3^{rd} grade parents' group will take place on separate days during the eighth week of programming and the 4^{th} and 5^{th} grade parents' groups will take place on separate days during the ninth week of programming.

The focus groups will be semi-structured with a guide list of interview questions to help stimulate conversation in the focus group. A high level of moderator involvement will help to ensure that each of the groups are presented with and spend comparable amounts of time on the focus group questions (Morgan, 2013). A bilingual translator will be available to help translate the researcher's questions into Spanish, as many parents in the school are monolingual Spanish speakers. Focus group sessions will run for about an hour directly after OST programs in the school media center. Six to ten participants in a focus group is an ideal number for these focus groups (Merriam & Tisdell, 2016).

Data collected from the focus groups will be derived from an interactive process of social construction (Merriam & Tisdell, 2015). The purpose of the focus groups will be to gain understanding about why parents enroll their students in OST programming, what academic or cognitive gains they perceive from their child during the program, and what changes are recommended to improve the programming (Appendix D). The focus groups will be recorded on a portable device, transcribed, and analyzed. Immediately following the focus group sessions, the files will be uploaded onto a computer and housed as a digital file, ready for transcriptions and subsequent coding. Transcriptions from the focus groups will be created using *Microsoft Word* software. Parent focus group data will be used to answer research question three. The parent focus group protocol is included in Appendix D.

Student focus groups. Like the parent focus groups, four student focus groups will be facilitated to address the third research question in the study. Four small groups of students (7-8 per group) in the study will participate in semi-structured focus groups for approximately 20 minutes during snack time at the beginning of programming during the eighth and ninth weeks of programming. The researcher will adopt the role of participant observer (Fine & Sandstrom, 1988). Since the researcher is already part of the school community and has established familiarity with students in after school programs, this role will allow the researcher to gain a glimpse of students' genuine thoughts without feeling that they are being watched over or evaluated by a stranger. The groups will include randomly selected students from the following groups: (1^{st} – 3^{rd} control, 1^{st} – 3^{rd} treatment, 4^{th}-5^{th} control, and 4^{th}-5^{th} treatment). For random selection, student names will be input into an Excel spreadsheet divided by age and group and will randomly be assigned numbers with the Excel random number generator function. The first eight student names in each group will be selected for focus groups. After the groups have been selected, 1^{st} through 3^{rd} grade students in the STEM OST group will participate in the first focus group session (week 8), 1^{st} through 3^{rd} grade students in the control OST group will participate in the second session (week 8), 4th and 5th grade students in the STEM OST group will participate in the third session (week 9), 4th and 5th grade students in the control OST group will participate in the fourth session (week 9).

During the focus group, which will be recorded for later transcription, the researcher will ask to use a list of interview questions to guide discussion about why the students chose to participate in the program, what programs they have participated in the past, what they have learned from the program, and recommendations for improvement (Emerson, Fretz, & Shaw, 2011). The student focus group protocol is included in Appendix E. Technology will be an invaluable tool in collecting and organizing focus group data and aiding with analysis. Portable recording technology will be used to record the student focus group sessions. Immediately following the sessions, the files will be uploaded onto a computer and housed as a digital file, ready for transcriptions. Transcriptions from the focus groups will be created using *Microsoft Word* software.

Program observations. Observation data will be helpful in revealing what types of activities the students are participating in during OST programs, the level of fidelity of the lessons and activities to the program objectives and goals, and the level of student participation in each STEM OST program. Each of the four STEM programs will be observed for the aforementioned elements. Observation protocol, including an observation guide and note template, is included in Appendix F.

A participant observer role will be adopted for the observations (Yin, 2014). The researcher will informally observe each of the programs at weeks three, six, and eight throughout the eight weeks of instruction. Observations will be approximately fifteen to twenty minutes. Notes will be recorded in the researcher's field notebook during the observation sessions and will subsequently be codified using a start list of provisional codes for analysis (Miles, Huberman, & Saldana, 2015). Trends in the data will be analyzed.

PEAR DoS. The PEAR DoS is a valid and reliable rubric designed as an observation-based assessment of STEM OST program quality (Shah, Wylie, Gitomer, & Noam, 2017). The measure includes a 12-dimension rubric and observation guide (PEAR Institute, 2017b). Among the twelve dimensions of quality-STEM programming are organization, materials, space utilization, participation, purposeful activities, engagement with STEM, STEM content learning, inquiry, reflection, relationships, relevance, and youth voice. The PEAR DoS is designed for use exclusively in STEM classrooms and will be used to evaluate the program quality of the treatment programs (STEM OST programs). The rubric will be a helpful tool in guiding the researcher to notice specific characteristics of STEM quality. The DoS rubric is omitted from this document, per PEAR's confidentiality guidelines.

The researcher will adopt the role of participant observer and will have a copy of the PEAR DoS rubric at hand when completing the program observations at weeks 3, 6, and 8. Notes will also be taken using the PEAR DoS observation guide. Notes from the observation guide will be codified using a start list of provisional codes for analysis (Miles, Huberman, & Saldana, 2015). Trends in the data will be analyzed. Rubrics will also be scored, compared, and analyzed.

Field notebook. A field notebook will house the researcher's notes taken during the twelve informal observations, interviews with teachers, and focus groups with parents and students. Jottings of informal thoughts and connections made throughout the data collection process will be included in the field notebook (Emerson, Fretz, & Shaw, 2011). The information recorded in the field notebook will be helpful, not only for data collection purposes, but also for generating a synthesis of findings and triangulating the various sources of data collected throughout the duration of the study.

Data Analysis

Quantitative Data

Student data will be analyzed by the intention-to-treat (ITT) approach to control for variations in student attendance or participant dropout, which would influence the overall analysis of the groups (Gupta, 2011). A subsequent per-protocol (dosage) analysis will also be performed to confirm and triangulate results from the ITT analytical approach (Shah, 2011). The reason that both approaches will be used is to eliminate bias and provide additional information about the influence of the treatment in the study. The predicted statistical analysis of the PEAR CIS and S-STEM 21st that will likely be most appropriate for this study will either be a t-test of the means of the control and treatment groups or an Analysis of Variance (ANOVA) to evaluate the variations in the group means between the two groups (Warner, 2013). The relatively small sample size of this study and the unknown variances of their distribution suggest a suitable fit for a t-test analysis. An ANOVA may be beneficial for teasing out the differences that emerge between the control and treatment groups. Additionally, a two-way ANOVA may be used to evaluate the influence of two different variables like students' ages (1st - 3rd and 4th - 5th) and program types on the continuous variables in the study (STEM attitudes and 21st century skills).

Qualitative Data

Qualitative research yields a robust collection of data. Organization of that data is critical for accurate analysis (Miles, Huberman, & Saldana, 2014). The transcriptions from the interviews, parent and student focus groups, and observations using the PEAR DoS rubric will be read several times so that the researcher is fully immersed in the data. Then each data source will be analyzed and coded using a start list of provisional codes (Miles, Huberman & Saldana, 2015). They will be subsequently analyzed for topic trends and themes. A second layer of coding analysis will be applied to find overarching themes within and among all the interviews, observations, and focus groups conducted in the study. Data from interviews and focus group responses will be entered into a conceptually clustered matrix to analyze relationships in responses, topics, and themes. Finally, a third level of selective coding analysis will be used to develop the narrative regarding the pertinent findings about student learning, which will emerge in the interviews, observations, and focus groups.

It is important to pursue parsimony when engaging in analysis of large amounts of qualitative data (Bazeley, 2013). It is easy to become lost in all the data generated by a qualitative study. However, stepping back and looking for the overarching patterns, ideas, and themes that emerge from the data is a necessary and effective way to find a parsimonious explanation for the study's findings. Mertens (2015) recommends that researchers avoid immersing themselves in data alone. Rather, they should continuously go back to the literature to help illuminate new or perplexing findings. Consulting the literature frequently throughout the study will be helpful in thoroughly explaining the findings that emerge in the study.

Triangulation of Data

A large quantity of qualitative and quantitative data will be collected throughout the study, specifically during weeks eight through eleven of programming. Both quantitative and qualitative data will be collected and closely analyzed simultaneously, which will aid in the triangulation process (Mertens, 2015). The simultaneous collection of qualitative and quantitative data will yield richer, more comprehensive findings. Results from the quantitative portions of the study (S-STEM and PEAR CIS pre and post surveys) will be extended and supported by the qualitative elements of the study including parent and student focus groups, teacher interviews, and classroom observations. Similarly, results from the quantitative findings will help to inform and confirm the qualitative findings. Both data types will be used to complement, deepen, and extend understanding about the role of OSTs in shaping students' attitudes toward STEM as well as 21st century skills.

Peer Audits

Peer audits preserve the objectivity and reliability of the findings of qualitative and mixed methods research studies (Anney, 2014). To ensure that the study includes objective and reliable findings, the researcher will submit data and findings to peers for questioning and confirmation. Once all data is collected, the researcher will share all data sets and qualitative measures paired with the codes and emergent themes. After one week allotted for review, the researcher and peer will meet to review the data and findings. The preliminary findings will be discussed with the understood purpose of exposing subjectivity or lack of consideration related to the data. Three sequential peer audits will take place in the weeks following the study.

Ethical Considerations

Once the study has received committee approval, it will be submitted to the Institutional Review Board at the University of Oklahoma. Maintaining ethical research practices is critical in ensuring that results are trustworthy, reliable, and valuable to the field (Glense, 2011). Participating in research with young students is an especially sensitive endeavor requiring the researcher's strict adherence to ethical research practices and transparency with the students' families (Fine & Sandstrom, 1988).

Every participant in the study (students, teachers, and parents) will complete a consent (or assent) form in either English (Appendices G through L). These consent forms will be filed and secured throughout the entirety of the study and beyond. Multiple formal and informal opportunities will be offered to meet with parents to discuss the purpose of the study and review each component of the consent form explaining the study in its entirety. The researcher and an interpreter (as needed) will meet with each interested family for approximately twenty minutes to answer questions about the study. In doing so, the researcher will adopt an explicit cover, making clear the methodological processes and purposes in the study (Fine & Sandstrom, 1988).

Trustworthiness

The most important measures of a study's usefulness are its measures of reliability and validity (Mertens, 2015; Merriam & Tisdell, 2016). To ensure that a study is trustworthy, prescribed measures of data triangulation and procedural clarity are important to maintain (Merriam & Tisdell, 2016). Regardless of the study's design-qualitative or quantitative- the importance of these measures is critical. Interestingly, different terms are used to describe the various measures of quality in quantitative and qualitative studies (Guba & Lincoln, 1989; Mertens, 2015). Credibility, transferability, dependability, and confirmability are all qualitative terms that are used synonymously with the respective quantitative terms: internal validity, external validity, reliability, and objectivity. Since the study included in this methodology is a mixed methods study and involves both quantitative and qualitative data collection methods, both sets of terms will be presented.

Credibility or Internal Validity

Credibility or internal validity connect the findings from a research study to reality (Merriam & Tisdell, 2016). A few methods for ensuring the quality of a qualitative study's credibility include prolonged and persistent engagement, member checks, and triangulation of data. For this study, credibility will be established by employing all these methods. Since the study will run for ten weeks, the researcher will engage in prolonged and persistent engagement with the study and its participants. The researcher interacts regularly with the study participants as she is an employee of the school in which the study will take place.

Member checks, or confirmations of findings with the parents (English and Spanish) and teachers as well as verbal member checks with the students in the study will promote the study's credibility. Member checks will be conducted on a follow-up basis with parents and students involved in the focus groups as well as teachers who participated in interviews. Documents containing a summary of findings and excerpts from the focus groups and interviews will be given to all participants with a request for confirmation or feedback on the findings. Any feedback received during the confirmation process will help to ensure that the findings are legitimate. The triangulation of all data collected including student observations, survey data, focus group findings, and teacher interviews will further support credibility. The internal validity of both the PEAR CIS and S-STEM surveys used in the study have been found to be high using exploratory factor analysis (Allen et al., 2016; Unfried et al., 2015).

Transferability or External Validity

Transferability involves the inclusion of a study sample that fairly represents the broader population. The sample in this study will include 40 students, 20 of whom will be in the treatment group and 20 students in the control group. Though the demographic makeup of these 40 students cannot be predicted at this time, the fact that the study takes place in a diverse community school suggests a strong likelihood that a high level of student diversity will be present. To add to the transferability of the study, the inclusion of thick description- a thorough description of time, place, context, and culture- will be included in the study (Mertens, 2015).

The external validity of the S-STEM survey used to collect quantitative data is high (Unfried et al., 2015). The number of students included in the validation study of the measure was 3,413. According to the self-reports of students who participated in the study, 50% were male and 50% female. Of the participants, 59.7% were White/Caucasian, 14.8% Black/African American, 9.8% Hispanic/Latino, 4.5% multiracial, 5.1% American Indian, 0.5% Asian, 0.6% Pacific Islander, and 5% Other. Similarly, the external validity of the PEAR CIS is also relatively high. The PEAR CIS norm group (n=1,599) included 45.8% were male and 54.2 female, 29.9% White/Caucasian, 25.1% Black/African American, 13.9% Hispanic/Latino, 10.4% multiracial, 2% American Indian, 3.5% Asian, 11.2% Native Hawaiian/Pacific Islander, and 4% Other

Dependability or Reliability

The dependability of a study exists in the procedural clarity and transparency of the study (Mertens, 2015: Patton, 2015). The thorough and clear presentation of the study's methodology contributes to its dependability. Additionally, a peer dependability audit provides an added layer of dependability. The study's design and implementation will undergo several peer audits to ensure that the study's dependability is intact. The PEAR CIS and S-STEM quantitative measures have been tested for reliability. The Cronbach's alpha values for the PEAR CIS are above .85. The Cronbach's alpha for the 21st century skills subsection is .87.

Confirmability or Objectivity

The final criteria for judging the quality of quantitative and qualitative research studies is confirmability or objectivity. These criteria demand that a study yields objective results and interpretations untainted by subjectivity on the part of the researcher (Mertens, 2015). Guba and Lincoln (2005) suggest that researchers participate in a confirmability audit to trace the data back to the sources from which they were derived. In this study, a meticulous chain of evidence will be documented in order to verify the confirmability or objectivity of the data and subsequent findings. This chain of evidence will include a documented list of all meetings and interactions related to the study. Summaries of each of those meetings, will be included in the chain of evidence.

Limitations

Sample size is the primary foreseeable limitation of the proposed study. The study includes a relatively small sample size (n=80), which may affect the generalizability of the results (Warner, 2013). The mixed-methods nature of the study creates a conflict in this area. On the quantitative side, having many participants is important in ensuring generalizability. However, it would be unrealistic to apply the qualitative methods described in the methodology to thousands of students and their families over the course of a ten-week program. The transferability of the results will emerge from the unique findings from data collected with the qualitative measures. Striking a balance between having enough quantitative data to determine significance and collecting a sufficient and manageable amount of qualitative data to fill in the gaps unaddressed by quantitative measures is challenging and was a consideration in the design of this study.

Significance

A lack of diversity in STEM related fields has prompted researchers and educational practitioners to examine whether or not students in low-SES, high-minority schools have equal opportunities to participate in high-quality STEM experiences as their peers in more affluent neighborhoods (Wright et al., 2017). Research about the STEM pipeline reveals that if students do not develop an interest in STEM related content, they are likely to fall out of the pipeline (Lyon et al., 2012). Falling out of the pipeline is an unfortunate reality for many Latino, Latina, and African American students. Community schools focus on providing equitable opportunities for all students and families, which includes the provision of STEM curriculum and OST programming.

Though an expanding body of research on extracurricular STEM programs has surfaced in response to the growing national need for professionals in STEM fields, there is a gap in research on the implementation of STEM programs in community schools and how they support students (Beckett et al., 2009; Karp & Maloner, 2013; Sahin, Ayar, & Adiguzel, 2014). This study seeks to fill the research gap and to uncover the significance between participating in high-quality STEM OST programs and changes in students' 21st century skills and attitudes toward STEM, both of which are important precursors for a lifelong interest in STEM content and professions.

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Appendix A: S-STEM for 4-5th Grade Students

Upper Elementary School Student Attitudes toward STEM (S-STEM) – 4th-5th

Directions and questions/answers will be displayed on a digital tablet. Students will be able to select their answers on the digital tablet screen one question at a time.

Directions:

There are lists of statements on the following pages. Please mark your answer sheets by marking how you feel about each statement. For example:

As you read the sentence, you will know whether you agree or disagree. Fill in the circle that describes how much you agree or disagree.

Even though some statements are very similar, please answer each statement. This is not timed; work fast, but carefully.

There are no "right" or "wrong" answers! The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice.

Please fill in on only one answer per question. Recommended citation for this survey:

Example 1:	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I like engineering.	○	○	○	○	○

Friday Institute for Educational Innovation (2012). Upper Elementary School Student Attitudes toward STEM Survey. Raleigh, NC: Author.

21st Century Skills

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I am confident I can lead others to accomplish a goal.					
2. I am confident I can encourage others to do their best.					
3. I am confident I can produce high quality work.					
4. I am confident I can respect the differences of my peers					
5. I am confident I can help my peers.					
6. I am confident I can include others' perspectives when making decisions.					
7. I am confident I can make changes when things do not go as planned.					
8. I am confident I can set my own learning goals					
9. I am confident I can manage my time wisely when working on my own.					
10. When I have many assignments, I can choose which ones need to be done first.					
11. I am confident I can work well with other kids who come from different backgrounds (who are not the same as me).					

Appendix B: Adapted S-STEM 21st Century Skills Measure for 1st – 3rd Grade Students

Lower Elementary School Student Attitudes toward STEM (S-STEM) – 1st-3rd

Directions and questions/answers will be displayed on a digital tablet. An adult will read the directions and each item to the children.

Directions:

There are lists of statements on the following pages. Please mark your answer sheets by marking how you feel about each statement. For example:

As you read the sentence, you will know whether you agree or disagree. Fill in the circle that describes how much you agree or disagree.

Even though some statements are very similar, please answer each statement. This is not timed; work fast, but carefully.

There are no "right" or "wrong" answers! The only correct responses are those that are true for you. Whenever possible, let the things that have happened to you help you make a choice.

Please fill in on only one answer per question. Recommended citation for this survey:

	☹ Disagree	☺ Agree
I like engineering.		

Friday Institute for Educational Innovation (2012). Upper Elementary School Student Attitudes toward STEM Survey. Raleigh, NC: Author.

21st Century Skills

	☹ No	☺ Yes
1. I show others how to reach a goal.		
2. I help others do their best.		
3. I always try to do my best work.		
4. I have different kinds of friends.		
5. I help the people in my class.		
6. I think about my classmates when I make choices.		
7. I fix things when they are not right.		
8. I set goals and I reach them.		
9. I get my work done on time.		
10. When I have a lot of things to do, I know which things I need to do first.		
11. I can be friends with people who are not like me.		

Appendix C: Teacher Interview Questions- Treatment and Control

Teacher Interview Questions

1. Why did you choose to teach the _____ program? What was it about the content of the program that made you want to teach that content?
2. What did you learn while teaching _____ program?
3. What did you enjoy/not enjoy about teaching ____ program?
4. What were your students' favorite activity/ies this semester?
5. What was the most important thing that you taught your students/that your students learned in ____ program?
6. How did teaching this program change the way the students felt about STEM?
7. What social skills did the students develop in _____ program?
8. How does the content of your program relate to school or home?
9. How did your program promote problem solving and teamwork?
10. What other information would you like to share with me about your experience teaching STEM (or other programming) this semester?

Appendix D: Parent Focus Group Discussion Prompts

Parent Focus Group Possible Guiding Questions:

1. What did you like about _____ program?
2. What did you dislike about _____ program?
3. What was your child's favorite activity in _____ program and why do you think it was their favorite?
4. How did being a part of _____ program change the way that your child thinks about STEM?
5. What social skills did your child develop while they participated in _____ program?
6. What new STEM knowledge has your student used in class, at home, or outside of school?
7. How has participating in _____ program helped your student learn how to solve problems?
8. How has participating in _____ program helped your student learn how to work in a team?
9. Do you think that you will enroll your child in other similar (STEM-based or non-STEM) programs in the future? Why/why not?

Appendix E: Student Focus Group Discussion Prompts

Student Focus Group Possible Guiding Questions:

1. What did you like about _____ program?
2. What did you dislike about _____ program?
3. What was your favorite activity in _____ program and why?
4. How did being a part of _____ program change the way that you think about STEM?
5. Would you like to learn more about the subject area of ____ program?
6. What new STEM knowledge have you used in class, at home, or outside of school?
7. How has participating in _____ program helped you learn how to solve problems?
8. How has participating in _____ program helped you learn how to work in a team?
9. What types of skills did you use when you worked with a partner or in a group?

Appendix F: Observation Protocol and Observation Template

Program evaluation observations will contribute to the qualitative component of the mixed methods study. Observations will take into consideration the program/unit/session objectives, plans, projected outcomes, and vocabulary.

Questions to guide the observations include:

- How do the activities in this session promote the overall program/unit/session goals?
- What vocabulary are students using that reveal content area learning?
- What skills are students learning in the program session? What instructional approaches are used and are students succeeding in acquiring the skill or accomplishing the task?
- What dispositions and attitudes are students displaying as they engage in the learning activity?
- What is the level of student engagement in the program activities?
- What 21st century skills (and anecdotal evidence) are students demonstrating as they engage in the learning activity?

    - *Collaboration and teamwork*
    - *Creativity and imagination*
    - *Critical thinking*
    - *Problem solving*
    - *Flexibility and adaptability*
    - *Information literacy*
    - *Leadership*
    - *Civic literacy*
    - *Citizenship*
    - *Oral and written communication skills*
    - *Social responsibility and ethics*
    - *Technology literacy*
    - *Ethic*

Observation Notes

Program: ________________________________ Grade:_______________________

Level:__________________________

Instructor: ____________________________

Observation Date and Time: _____________________________________

Notes:

Appendix G: Parent Signed Consent for Child to Participate in Research (English)

701-A-4

Signed Parental Permission to Participate in Research

Will you allow your child to be involved in research at the University of Oklahoma?

I am Laura Latta from the Instructional Leadership and Academic Curriculum department at the University of Oklahoma and I invite your child to participate in my research project entitled The Effects of STEM Out-of-School-Time Programming on the Development of STEM (Science, Technology, Engineering, and Math) Attitudes and 21st Century Skills of Community School Students. This research is being conducted at Rosa Parks Elementary. Your child was selected as a possible participant because they are enrolled in out-of-school-time programs at Rosa Parks.

Please read this document and contact me to ask any questions that you may have BEFORE allowing your child to participate in my research.

What is the purpose of this research? The purpose of this research is to examine how out-of-school-time (OST) Science, Technology, Engineering, and Mathematics (STEM) programs influence students' attitudes about STEM and their development of 21st century skills (i.e. critical thinking, collaboration, creativity, and communication) over the course of a ten-week program.

How many participants will be in this research? About 250 people will take part in this research including students, parents, and teachers.

What will my child be asked to do? If you allow your child to be in this research, s/he will take a pre and post, web-based survey at the beginning and end of the ten weeks of out-of-school-time programming. The survey is designed to show changes in STEM attitudes and 21st century skills over the course of a program. Your child will also participate in a focus group discussion about after school programs.

How long will this take? The study will be conducted for 10-11 weeks during the 2018-2019 school year. Surveys will take about 10-15 minutes to complete and focus groups will last approximately 30 to 45 minutes.

What are the risks and/or benefits if my child participates? There are no risks and no benefits from being in this research.

Will my child be compensated for participating? Your child will not be reimbursed for her/his time and participation in this research.

Who will see my child's information? In research reports, there will be no information that will make it possible to identify your child. Research records will be stored securely and only approved researchers and the OU Institutional Review Board will have access to the records. In addition, the McLean Hospital's PEAR Institute, developers of the web-based PEAR CIS survey, will have access to the research records.

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/25/2018
IRB EXPIRATION DATE: 08/31/2019

Revised 03/01/15
Page 1 of 2

Does my child have to participate? No. If your child does not participate, s/he will not be penalized or lose benefits or services unrelated to the research. If your child does participate, s/he doesn't have to answer any question and can stop participating at any time.

Will my child's identity be anonymous or confidential? Your child's name will not be retained or linked with her/his responses. The data will be retained in anonymous form at the end of the research.

Audio Recording of Research Activities To assist with accurate recording of your child's responses, focus groups may be recorded on an audio recording device. You have the right to refuse to allow such recording without penalty.

I consent to audio recording. ___ Yes ___ No

Will I be contacted again? The researcher would like to contact you again to recruit your child into this research or to gather additional information.

_____ I give my permission for the researcher to contact me in the future.

_____ I do not wish to be contacted by the researcher again.

Who do I contact with questions, concerns or complaints? If you have questions, concerns or complaints about the research, contact me (Laura Latta) at laura.latta@ou.edu or 918-237-3473. You may also contact Dr. Vickie Lake, assistant dean of the ILAC program at OU-Tulsa, at 918-660-3984.

You can also contact the University of Oklahoma – Norman Campus Institutional Review Board (OU-NC IRB) at 405-325-8110 or irb@ou.edu if you have questions about your child's rights as a research participant, concerns, or complaints about the research and wish to talk to someone other than the researcher(s) or if you cannot reach the researcher(s).

You will be given a copy of this document for your records. By providing information to the researcher(s), I am allowing my child to participate in this research.

Child's Name (Parent write in)		Date
Child's Signature		Date
Parent's Signature	Print Name	Date
Signature of Researcher Obtaining Consent	Print Name	Date

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/25/2018
IRB EXPIRATION DATE: 08/31/2019

Appendix H: Parent Signed Consent for Child to Participate in Research (Spanish)

Permiso Parental para Participar en la Investigación

¿Permitirá que su hijo participe en investigaciones en la Universidad de Oklahoma? Soy Laura Latta del departamento de Liderazgo Educativo y Currículo Académico de la Universidad de Oklahoma e invito a su hijo a participar en mi proyecto de investigación titulado Los Efectos de la Programación STEM fuera del horario escolar sobre el Desarrollo de STEM (Ciencia, Tecnología, Ingeniería y Matemáticas) Actitudes y Habilidades del Siglo 21 de los Estudiantes de las Escuelas Comunitarias. Esta investigación se lleva a cabo en Rosa Parks Elementary. Su hijo fue seleccionado como posible participante porque están inscritos en programas fuera de la escuela en Rosa Parks.

Lea este documento y contácteme para hacerme cualquier pregunta que pueda tener ANTES de permitir que su hijo participe en mi investigación.

¿Cuál es el propósito de esta investigación? El propósito de esta investigación es examinar cómo los programas de Ciencia, Tecnología, Ingeniería y Matemáticas (STEM) fuera del horario escolar influyen en las actitudes de los estudiantes sobre STEM y su desarrollo de las habilidades del siglo XXI (es decir, pensamiento crítico, colaboración , creatividad y comunicación) en el transcurso de un programa de diez semanas.

¿Cuántos participantes estarán en esta investigación? Alrededor de 250 personas participarán en esta investigación, incluidos estudiantes, padres y maestros.

¿Qué se le pedirá a mi hijo que haga? Si permite que su hijo participe en esta investigación, realizará una encuesta previa y posterior en la web al comienzo y al final de las diez semanas de programación fuera de la escuela. La encuesta está diseñada para mostrar los cambios en las actitudes STEM y las habilidades del siglo 21 en el transcurso de un programa. Su hijo también participará en una discusión grupal sobre programas después de la escuela.

¿Cuánto tiempo llevará esto?
El estudio se llevará a cabo durante 10-11 semanas durante el año lectivo 2018-2019. Las encuestas tomarán entre 10 y 15 minutos para completarse y los grupos de enfoque durarán aproximadamente de 30 a 45 minutos.

¿Cuáles son los riesgos y / o beneficios si mi hijo participa? No hay riesgos ni beneficios de estar en esta investigación.
¿Se le compensará a mi hijo por participar? No se le reembolsará a su hijo (a) su tiempo y participación en esta investigación.

¿Quién verá la información de mi hijo? En los informes de investigación, no habrá información que permita identificar a su hijo. Los registros de investigación se almacenarán de forma segura y solo los investigadores aprobados y la Junta de Revisión Institucional de OU tendrán acceso a los registros. Además, el Instituto PEAR del Hospital McLean (Universidad de Harvard), los desarrolladores de la encuesta PEAR CIS basada en la web, tendrán acceso a los registros de investigación.

¿Mi hijo tiene que participar? No. Si su hijo no participa, no será penalizado o perderá

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/25/2018
IRB EXPIRATION DATE: 08/31/2019

beneficios o servicios no relacionados con la investigación. Si su hijo participa, él / ella no tiene que responder ninguna pregunta y puede dejar de participar en cualquier momento.

¿La identidad de mi hijo será anónima o confidencial? El nombre de su hijo no será retenido o vinculado con sus respuestas. Los datos se conservarán en forma anónima al final de la investigación.

Grabación de audio de actividades de investigación Para ayudar con la grabación precisa de las respuestas de su hijo, los grupos de enfoque pueden grabarse en un dispositivo de grabación de audio. Usted tiene el derecho de negarse a permitir tal grabación sin penalidad.
Doy mi consentimiento a la grabación de audio. ___ Si ___ no

¿Seré contactado nuevamente? El investigador desea contactarlo de nuevo para reclutar a su hijo en esta investigación o para recopilar información adicional.
_____ Doy mi permiso para que el investigador me contacte en el futuro.
_____ No deseo ser contactado por el investigador nuevamente.

¿A quién contacto con preguntas, inquietudes o quejas? Si tiene preguntas, inquietudes o quejas sobre la investigación, comuníquese conmigo (Laura Latta) a laura.latta@ou.edu o al 918-237-3473. También puede contactar al Dr. Vickie Lake, decano asistente del programa ILAC en OU-Tulsa, al 918-660-3984.

También puede comunicarse con la Junta de Revisión Institucional de la Universidad de Oklahoma - Norman Campus (OU-NC IRB) al 405-325-8110 o irb@ou.edu si tiene preguntas sobre los derechos de su hijo como participante de la investigación, inquietudes o quejas sobre la investigación y desea hablar con alguien que no sea el (los) investigador (es) o si no puede contactar al (los) investigador (es).

Se le entregará una copia de este documento para su registro. Al proporcionar información al investigador (es), le permito a mi hijo participar en esta investigación.

Nombre del niño (el padre escribe adentro)		Fecha
Firma del niño		Fecha
Firma de los padres	Imprimir nombre	Fecha
Firma del investigador que obtiene el consentimiento	Imprimir nombre	Fecha
Firma del testigo (si corresponde)	Imprimir nombre	Fecha

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/25/2018
IRB EXPIRATION DATE: 08/31/2019

Appendix I: Parent Consent to Participate in Research (Focus Groups; English)

701-A-1

Signed Consent to Participate in Research (Parent)

Would you like to be involved in research at the University of Oklahoma?

I am Laura Latta from the Instructional Leadership and Academic Curriculum department at the University of Oklahoma and I invite you to participate in my research project entitled The Effects of STEM Out-of-School-Time Programming on the Development of STEM (Science, Technology, Engineering, and Math) Attitudes and 21st Century Skills of Community School Students. This research is being conducted at Rosa Parks Elementary. You were selected as a possible participant because you are a parent of a student enrolled in Rosa Parks out-of-school-time programs. You must be at least 18 years of age to participate in this study.

Please read this document and contact me to ask any questions that you may have BEFORE agreeing to take part in my research.

What is the purpose of this research? The purpose of this research is to examine how out-of-school-time (OST) Science, Technology, Engineering, and Mathematics (STEM) programs influence students' attitudes about STEM and their development of 21st century skills (i.e. critical thinking, collaboration, creativity, and communication) over the course of a ten-week program.

How many participants will be in this research? About 250 people will take part in this research including students, parents, and teachers.

What will I be asked to do? If you agree to be in this research, you will participate in one 30-60 minute focus group about OST programs.

How long will this take? Your participation will take 30-60 minutes.

What are the risks and/or benefits if I participate? There are no risks and no benefits from being in this research.

Will I be compensated for participating? You will not be reimbursed for your time and participation in this research.

Who will see my information? In research reports, there will be no information that will make it possible to identify you. Research records will be stored securely and only approved researchers and the OU Institutional Review Board will have access to the records.

You have the right to access the research data that has been collected about you as a part of this research. However, you may not have access to this information until the entire research has completely finished and you consent to this temporary restriction.

Do I have to participate? No. If you do not participate, you will not be penalized or lose benefits or services unrelated to the research. If you decide to participate, you don't have to answer any question and can stop participating at any time.

Will my identity be anonymous or confidential? Your name will not be retained or linked with your responses unless you specifically agree to be identified. Please check all of the options that you agree to:

I agree to being quoted directly. ___ Yes ___ No

Audio Recording of Research Activities To assist with accurate recording of your responses, focus groups may be recorded on an audio recording device. You have the right to refuse to allow such recording without penalty. If you do not agree to audio-recording, you cannot participate in this research.

I consent to audio recording. ___Yes ___ No

What happens in the future? The researcher might like to contact you to gather additional data, recruit you into new research, or use your data again in other studies.

I give my permission for the researcher to contact me in the future. ___Yes ___ No

I agree for the researcher to use my identifiable data in future studies. ___Yes ___ No

Who do I contact with questions, concerns or complaints? If you have questions, concerns or complaints about the research, contact me (Laura Latta) at laura.latta@ou.edu or 918-237-3473. You may also contact Dr. Vickie Lake, assistant dean of the ILAC program at OU-Tulsa, at 918-660-3984.

You can also contact the University of Oklahoma – Norman Campus Institutional Review Board (OU-NC IRB) at 405-325-8110 or irb@ou.edu if you have questions about your rights as a research participant, concerns, or complaints about the research and wish to talk to someone other than the researcher(s) or if you cannot reach the researcher(s).

You will be given a copy of this document for your records. By providing information to the researcher(s), I am agreeing to participate in this research.

Participant Signature	Print Name	Date
Signature of Researcher Obtaining Consent	Print Name	Date

Appendix J: Parent Consent to Participate in Research (Focus Groups; Spanish)

701-A-1

Consentimiento Firmado Para Participar En Investigación (padres)

¿Le gustaría participar en investigaciones de la Universidad de Oklahoma? Soy Laura Latta del departamento de Liderazgo Educativo y Currículo Académico de la Universidad de Oklahoma y los invito a participar en mi proyecto de investigación titulado Los Efectos de la Programación STEM fuera del horario escolar sobre el Desarrollo de STEM (Ciencia, Tecnología, Ingeniería y Matemáticas) Actitudes y Habilidades del Siglo 21 de los Estudiantes de las Escuelas Comunitarias. Esta investigación se lleva a cabo en Rosa Parks Elementary. Usted fue seleccionado como posible participante porque es padre de un estudiante inscrito en los programas fuera de la escuela de Rosa Parks. Debe tener al menos 18 años de edad para participar en este estudio.

Lea este documento y contácteme para hacerme cualquier pregunta que pueda tener ANTES de aceptar participar en mi investigación.

¿Cuál es el propósito de esta investigación? El propósito de esta investigación es examinar cómo los programas de Ciencia, Tecnología, Ingeniería y Matemáticas (STEM) fuera del horario escolar influyen en las actitudes de los estudiantes sobre STEM y su desarrollo de las habilidades del siglo XXI (es decir, pensamiento crítico, colaboración , creatividad y comunicación) en el transcurso de un programa de diez semanas.

¿Cuántos participantes estarán en esta investigación? Alrededor de 250 personas participarán en esta investigación, incluidos estudiantes, padres y maestros.

¿Qué se me pedirá que haga? Si acepta participar en esta investigación, participará en un grupo focal de 30-60 minutos sobre los programas OST.

¿Cuánto tiempo llevará esto? Su participación tomará de 30 a 60 minutos.

¿Cuáles son los riesgos y / o beneficios si participo? No hay riesgos ni beneficios de estar en esta investigación.

¿Me compensarán por participar? No se le reembolsará el tiempo y la participación en esta investigación.

¿Quién verá mi información? En los informes de investigación, no habrá información que permita identificarlo. Los registros de investigación se almacenarán de forma segura y solo los investigadores aprobados y la Junta de Revisión Institucional de OU tendrán acceso a los registros.
Tiene derecho a acceder a los datos de investigación que se han recolectado sobre usted como parte de esta investigación. Sin embargo, es posible que no tenga acceso a esta información hasta que la investigación sea haya finalizado por completo y usted consiente en esta restricción temporal.

¿Debo participar? No. Si no participa, no será penalizado ni perderá beneficios o servicios no relacionados con la investigación. Si decide participar, no tiene que responder ninguna pregunta y puede dejar de participar en cualquier momento.

¿Mi identidad será anónima o confidencial? Su nombre no será retenido o vinculado con sus respuestas a menos que usted específicamente acepte ser identificado. Marque todas las opciones que acepta:

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/25/2018
IRB EXPIRATION DATE: 08/31/2019

Revised 03/01/15
Page 1 of 2

Acepto ser citado directamente. ___ Si ___ No

Grabación de audio de actividades de investigación Para ayudar con la grabación precisa de sus respuestas, los grupos de enfoque pueden grabarse en un dispositivo de grabación de audio. Usted tiene el derecho de negarse a permitir tal grabación sin penalidad. Si no acepta la grabación de audio, no puede participar en esta investigación.

Doy mi consentimiento a la grabación de audio. ___Si ___No

¿Qué pasa en el futuro? Es posible que el investigador desee ponerse en contacto con usted para recopilar datos adicionales, reclutarlo para una nueva investigación o utilizar sus datos nuevamente en otros estudios.

Doy mi permiso para que el investigador me contacte en el futuro. ___Si ___No
Estoy de acuerdo con que el investigador use mis datos identificables en futuros estudios.

___Si ___ No

¿A quién contacto con preguntas, inquietudes o quejas? Si tiene preguntas, inquietudes o quejas sobre la investigación, comuníquese conmigo (Laura Latta) a laura.latta@ou.edu o al 918-237-3473. También puede contactar al Dr. Vickie Lake, asistente al decano del programa ILAC en OU-Tulsa, al 918-660-3984.
También puede comunicarse con la Junta de Revisión Institucional de la Universidad de Oklahoma - Norman Campus (OU-NC IRB) al 405-325-8110 o irb@ou.edu si tiene preguntas sobre sus derechos como participante de la investigación, inquietudes o quejas sobre la investigación y desea hablar con alguien que no sea el (los) investigador (es) o si no puede contactar al (los) investigador (es).

Se le entregará una copia de este documento para su registro. Al proporcionar información al investigador (es), estoy de acuerdo en participar en esta investigación.

Firma del Participante	Imprimir Nombre	Fecha
Firma del Investigador Obteniendo Consentimiento	Imprimir Nombre	Fecha

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/25/2018
IRB EXPIRATION DATE: 08/31/2019

Appendix K: Student Verbal and Written Assent to Participate in Research

701-A-3

Oral Assent Script to Participate in Research (for Students Younger than 7)

Hi, I am Laura Latta from the University of Oklahoma. I am doing a research project to learn about how STEM out-of-school-time programs help students learn new things. I am asking you to help because I want to learn from kids like you. In the whole research project, there will be about 195 children who have enrolled in after school programs at Rosa Parks.

Your Mom or Dad gave their permission for you to help me. I have told them about what I am asking you to do, and they said it was ok for you to work with me. The choice is still up to you, though.

If you agree to be in this research project, your teacher and I are going to ask you to answer many questions. These questions will ask you about how you feel about science, technology, engineering, and mathematics (STEM) as well as how you feel about your after school programs.

You will be in the research project for about 11 weeks at Rosa Parks Elementary. You will take a 15 minute survey at the beginning and end of programs and you may be asked to answer questions with a small group of other students.

You will get to share your thoughts about STEM and your out-of-school time programs. However, the questions might take a long time to answer.

If you don't want to, you do not have to be a part of this research project. No one will be mad at you if you don't want to do this. If you don't want to do this, just tell me. If you do want to be in the research project, tell me that. You can say yes now and change your mind later. It's up to you.

You can ask questions any time. You can ask now. You can ask later. You can talk to me or you can talk to someone else. If you say "yes", that you want to be a part of the research project, it means that you understand what I have said and want to be in the research project. If you don't want to be in the research project, say "no". Being in the research project is up to you, and no one will be upset if you don't want to be in the research project or if you change your mind later.

Child's Name	Response	Date

SIGNATURE OF PERSON CONDUCTING ASSENT DISCUSSION
I have explained the research project to ______________________(*print name of child here*) in language he/she can understand, and s/he has agreed to be in the research project.

Signature of Person Conducting Assent Discussion	Date
Name of Person Conducting Assent Discussion (*print*)	

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/2
IRB EXPIRATION DATE: 08/

Revised 10/28/2015
Page 1 of 1

701-A-6

Signed Child Assent (7-11 years)

Why are we meeting with you?
I am Laura Latta from the University of Oklahoma. I am doing a research project to learn about how STEM out-of-school-time programs help students learn new things. We are asking you to help because we want to learn from kids like you. In the whole research project, there will be about 195 children who have enrolled in after school programs at Rosa Parks.

Your Mom or Dad gave their permission for you to help me. I have told them about what I am asking you to do, and they said it was ok for you to work with me. The choice is still up to you, though.

What will happen to you if you are in this research project?
If you agree to be in this research project, we are going to ask you to answer a lot of questions. These questions will ask you about how you feel about science, technology, engineering, and mathematics (STEM) as well as how you feel about your after school programs.

How long will you be in the research project?
You will be in the research project for about 11 weeks at Rosa Parks Elementary. You will take a 15 minute survey at the beginning and end of programs and you may be asked to answer questions with a small group of other students.

What good things might happen to you if you are in the research project? You will get to share your thoughts about STEM and your out-of-school time programs.

What other things might happen to you if you are in the research project? The questions might take a long time to answer.

Do you have to be in this research project?
No, you don't. No one will be mad at you if you don't want to do this. If you don't want to do this, just tell me. If you do want to be in the research project, tell me that. You can say yes now and change your mind later. It's up to you.

Do you have any questions?
You can ask questions any time. You can ask now. You can ask later. You can talk to me or you can talk to someone else. If you sign this paper, it means that you understand what this letter says and want to be in the research project. If you don't want to be in the research project, don't sign this paper. Being in the research project is up to you, and no one will be upset if you don't sign this paper or if you change your mind later.

The person who talks to you will give you a copy of this form to keep.

Signature of Child	Date

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/25/2018
IRB EXPIRATION DATE: 08/31/2019

Appendix L: Teacher Consent to Participate in Research

701-A-1

Signed Consent to Participate in Research

Would you like to be involved in research at the University of Oklahoma?

I am Laura Latta from the Instructional Leadership and Academic Curriculum department at the University of Oklahoma and I invite you to participate in my research project entitled The Effects of STEM Out-of-School-Time Programming on the Development of STEM (Science, Technology, Engineering, and Math) Attitudes and 21st Century Skills of Community School Students. This research is being conducted at Rosa Parks Elementary. You were selected as a possible participant because you teach an out-of-school-time (OST) program at Rosa Parks Elementary. You must be at least 18 years of age to participate in this study.

Please read this document and contact me to ask any questions that you may have BEFORE agreeing to take part in my research.

What is the purpose of this research? The purpose of this research is to examine how out-of-school-time (OST) Science, Technology, Engineering, and Mathematics (STEM) programs influence students' attitudes about STEM and their development of 21st century skills (i.e. critical thinking, collaboration, creativity, and communication) over the course of a ten-week program.

How many participants will be in this research? About 250 people will take part in this research including students, parents, and teachers.

What will I be asked to do? If you agree to be in this research, your OST program will be observed 3 times for 15-20 minutes each time and you will participate in one 30-60 minute interview at the end of programming.

How long will this take? Your participation will take place at various points throughout the study. The study will be conducted for 11 weeks during the 2018-2019 school year. Program observations will take place three times throughout the semester (weeks 3, 6, and 8), with each observation lasting for 15-20 minutes. Interviews will be scheduled during the last week of programming and will last for 30-60 minutes.

What are the risks and/or benefits if I participate? There are no risks and no benefits from being in this research.

Will I be compensated for participating? You will not be reimbursed for your time and participation in this research.

Who will see my information? In research reports, there will be no information that will make it possible to identify you. Research records will be stored securely and only approved researchers and the OU Institutional Review Board will have access to the records.

You have the right to access the research data that has been collected about you as a part of this research. However, you may not have access to this information until the entire research has completely finished and you consent to this temporary restriction.

Do I have to participate? No. If you do not participate, you will not be penalized or lose benefits or services unrelated to the research. If you decide to participate, you don't have to answer any question and can stop participating at any time.

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/25/2018
IRB EXPIRATION DATE: 08/31/2019

Revised 03/01/15
Page 1 of 2

Will my identity be anonymous or confidential? Your name will not be retained or linked with your responses unless you specifically agree to be identified. Please check all of the options that you agree to:

I agree to being quoted directly. ___ Yes ___ No

Audio Recording of Research Activities To assist with accurate recording of your responses, interviews may be recorded on an audio recording device. You have the right to refuse to allow such recording without penalty.

I consent to audio recording. ___Yes ___ No

What happens in the future? The researcher might like to contact you to gather additional data, recruit you into new research, or use your data again in other studies.

I give my permission for the researcher to contact me in the future. ___Yes ___ No

I agree for the researcher to use my identifiable data in future studies. ___Yes ___ No

Who do I contact with questions, concerns or complaints? If you have questions, concerns or complaints about the research, contact me (Laura Latta) at laura.latta@ou.edu or 918-237-3473. You may also contact Dr. Vickie Lake, assistant dean of the ILAC program at OU-Tulsa, at 918-660-3984.

You can also contact the University of Oklahoma – Norman Campus Institutional Review Board (OU-NC IRB) at 405-325-8110 or irb@ou.edu if you have questions about your rights as a research participant, concerns, or complaints about the research and wish to talk to someone other than the researcher(s) or if you cannot reach the researcher(s).

You will be given a copy of this document for your records. By providing information to the researcher(s), I am agreeing to participate in this research.

Participant Signature	Print Name	Date
Signature of Researcher Obtaining Consent	Print Name	Date

Revised 03/01/15
Page 2 of 2

IRB NUMBER: 9787
IRB APPROVAL DATE: 09/25/2018
IRB EXPIRATION DATE: 08/31/2019

Appendix M: Study Timeline and Planned Publications

Research Design: Convergent mixed methods study, quasi-experimental design with one treatment and one control group.

Evaluations Used: PEAR Common Instrument Suite, S-STEM 21st century skills survey- original and adapted for ECE (pre & post), Observations using PEAR Dimensions of Success (DoS) (weeks 3, 6, and 8), Student Learning focus group (post) Teacher Instruction Interviews (post), Parent focus group (post)

Research Focus: Student STEM attitudes, Self-perception of 21st century goals and academic outcomes

Utility of Findings: Program Improvement, Contribution to community schools body of research, communication with partnerships

March – April 2018	• Conversation with District about Research Plan
June – July 2018	• MOU Completion with District • Adapt S-STEM 21st Century Skill Measure for Early Childhood
June – August 2018	• STEM OST Program Curricular Search & Refinement (Alignment to OAS Math Standards) • Complete IRB Process
September 2018	• Sample Identification- Students involved in STEM OST programming • Program identification- Determine which programs will be included in research. Criteria: STEM • Obtain parent consent to participate in research • Pre-Evaluation- Quantitative PEAR CIS and S-STEM Surveys
September & October 2018	• STEM Program Observations using PEAR DoS Rubric (weeks 3, 6, and 8)

November & December 2018	• STEM Program Observations using PEAR DoS Rubric (weeks 3, 6, and 8) • Post Evaluation (Weeks 8 & 9)- Parent Focus Group • Post Evaluation (Weeks 8 & 9)- Teacher Interviews • Post Evaluation (Weeks 8 & 9)- Student Focus Groups • Post Evaluation (Week 10)- Quantitative PEAR CIS and S-STEM Surveys **END OF RESEARCH WINDOW EVALUATION (End of Programming)**
January - April 2019	• Synthesize findings from Fall Programming • S-STEM Survey Results Analysis- SPSS • Qualitative Research Analysis- Trend Analysis, Dedoose • Recommend program improvement changes • Defend Dissertation
May 2019	• Publish Findings

Planned Publications:

Journal Type	Journal Name	Article Topic	Research Qs Answered
Practitioner	*Afterschool Matters*	STEM OST Programs in Community Schools	Q3
Theoretical	*Journal of Education and Practice*	Supporting academic improvement in community schools: A multi-layered approach	Q1, Q2
Empirical	*International Journal of STEM Education*	The Effects of STEM Out-of-School Programming on the Development of STEM Attitudes and 21st Century Skills of Community School Students	Q1, Q2, & Q3

APPENDIX B: INTERNAL REVIEW BOARD APPROVAL

The UNIVERSITY of OKLAHOMA

Institutional Review Board for the Protection of Human Subjects

Approval of Initial Submission – Expedited Review – AP01

Date: September 25, 2018

IRB#: 9787

Principal Investigator: Laura Ashlyn Latta

Approval Date: 09/25/2018

Expiration Date: 08/31/2019

Study Title: The Effects of STEM Out-of-School-Time Programming on the Development of STEM (Science, Technology, Engineering, and Math) Attitudes and 21st Century Skills of Community School Students

Expedited Category: 6 & 7

Collection/Use of PHI: No

On behalf of the Institutional Review Board (IRB), I have reviewed and granted expedited approval of the above-referenced research study. To view the documents approved for this submission, open this study from the *My Studies* option, go to *Submission History*, go to *Completed Submissions* tab and then click the *Details* icon.

As principal investigator of this research study, you are responsible to:

- Conduct the research study in a manner consistent with the requirements of the IRB and federal regulations 45 CFR 46.
- Obtain informed consent and research privacy authorization using the currently approved, stamped forms and retain all original, signed forms, if applicable.
- Request approval from the IRB prior to implementing any/all modifications.
- Promptly report to the IRB any harm experienced by a participant that is both unanticipated and related per IRB policy.
- Maintain accurate and complete study records for evaluation by the HRPP Quality Improvement Program and, if applicable, inspection by regulatory agencies and/or the study sponsor.
- Promptly submit continuing review documents to the IRB upon notification approximately 60 days prior to the expiration date indicated above.
- Submit a final closure report at the completion of the project.

If you have questions about this notification or using iRIS, contact the IRB @ 405-325-8110 or irb@ou.edu.

Cordially,

Aimee Franklin

Aimee Franklin, Ph.D.
Chair, Institutional Review Board