Connecting STEM Curriculum with Social Emotional Learning in Early Childhood

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Abstract

The purpose of this study is to explore how STEM based curriculum integrated with the Social Emotional Learning (SEL) framework already in place can enhance learning and overall development in early childhood learners. Participants were preschoolers (N=24) between the ages of 3-5 enrolled in a summer program offered at a midwestern mid sized university. This study collected both quantitative and qualitative data and used control and experimental groups. The control group followed the standard curriculum procedures already in place and the experimental group included STEM curriculum without SEL instructions. Data was analyzed using descriptive statistics. Using the variables of Directions, Observe, and Comparison, there were no significant difference between the groups with p-values ranging from .167 and .485. This means that under the current conditions, there is no significant difference between the groups. The results and limitations are discussed, and recommendations for future research is presented.

Introduction

Science, Technology, Engineering, and Mathematics (STEM) has been a growing topic of discussion among multiple disciplines for the past decade but is most notably recognized for its connection to education. The goal of STEM education among many global initiatives is to provide greater opportunities for success and prosperity of people, therefore increasing the economic success of their respective countries. STEM education focuses on the integration of science, technology, engineering and mathematics, rather than teaching them individually and is often associated with problem based learning (PBL) or project oriented problem based learning (POPBL). PBL is the practice of teaching students through the solving of practical problems rather than lecture based instruction. This is done to place emphasis on the interdependence of these subjects in real world situations, such as a structural engineer's dependence on mathematics and technology to create an effective and safe bridge. However, there has been some concerns related to current status of education in the US. For example, Schmidt (2011) indicated that US students are underperforming in the areas of Math and Science, a fact that could lead to political implication to the U.S. at the global level. An additional concern relates to the long known achievement gap among different groups of students based on their educational opportunities. The perceived achievement gap is believed to keep jobs opportunities out of the reach of minorities or under represented groups. STEM education has the potential address the achievement gap related to the 21st century skills and workforce (Stotts, 2011; Young et al., 2011). It is typically accepted that in today's ever changing world that STEM education is vital not only to the success of individual students, but also to the success of entire nations and the world. In President Obama's 2011 State of the Union Address, the President voiced his desire to improve the United State's STEM instruction by stating that, "We know what it takes to compete for the jobs and industries of our time. We need to out-innovate, out-educate, and out-build the rest of the world. We have to make America the best place on Earth to do business" (Obama, 2011)
Along with the United States' commitment to the improvement of STEM education, many other developed and developing countries around the world are committed to and are dependent upon the success of their STEM education programs. To cite an example, Malaysia's National Council for Scientific Research and Development, for example, estimates that Malaysia will need 493,830 scientists and engineers by 2020. Although the importance of STEM curriculum in K12 settings is well documented, less efforts have been made in to incorporate STEM in early childhood and early elementary years. According to Swift and Watkins (2004) math and science should be exposed in early grades for long term success in these subjects. Additionally, a report by the National Science Board published in 2010 strongly supports early exposure to STEM as a way to keep students interested in pursuing additional math and science learning opportunities in subsequent years.

Social emotional learning (SEL) is instruction that focuses on students' development of socially acceptable behavior as well as understanding and regulation of emotions. Similar to the rising popularity of STEM in all levels of education, the use of SEL curriculums in early childhood education has grown significantly as evidenced by research in the past decade. According to Durlak (2011) it is with good reason that SEL has grown at the rate that it has. Another study in the effects of social emotional interventions on academic classroom instruction time reported,
our results suggest that children in FOL [Foundations of Learning, a prominent social emotional intervention] classrooms scored lower on conflictual interactions with both teachers and peers based on observations by trained coders. Moreover, there was some suggestion, at the trend level, of higher levels of self-control, greater levels of focus, and higher levels of participation in classroom activities for children in FOL classrooms. brackets added (Morris, 2013, p. 1039).
Improved student to teacher and student to peer relationships as well as increased positive student behavior found in studies like this have been encouraging to researchers and educators alike, especially because of its implications for students later in life. Jones and Doolittle (2017) begin their review of SEL research by pointing out that, "Research increasingly suggests that social and emotional learning (SEL) matters a great deal for important life outcomes like success in school, college entry and completion, and later earnings" (p. 3).
The positive learning environment and longitudinal success determined by previous research in SEL and STEM education is the foundation of and inspiration for this study.

Literature Review

The fact that students in United States of America are not proficient in Science and Mathematics has been documented by several scholars (Schmidt, 2011; Stotts 2011) and has become a common issue among STEM educators, policy makers and the American community as a whole. As STEM education has grown over the years to meet the rising demand for technically trained professionals and a better educated public, research on various methods of STEM education has grown as well. An important note to understand is that the term STEM is not a unified term and can be interpreted differently by different groups of people. In some cases STEM education refers to exclusive programs that focus on developing the talents of gifted students. Many K-12 programs and researchers refer to STEM as an inclusive initiative intended for all students. Isha DeCoito (2014), identifies STEM as "the intersection of science, technology, engineering and mathematics. It is an approach to solving problems in a holistic way; seeing how the components of STEM interact with and inform each other" (p. 34). This integrated method is often cited by programs that address the issue of a lack of STEM professionals by seeking to better educate all members of the public. Those who hold to this view believe that emphasizing STEM to all students is beneficial because of the skills that are included in this method of learning such as, collaboration, critical thinking and creativity. Decoito (2014) continues in his journal article, *Focusing on Science, Technology, Engineering, and Technology in the 21st Century*, by stating "STEM facts, principles and techniques are highly transferable skills that enhance an individual's ability to succeed in school and beyond, across a wide array of disciplines" (p. 23). An inclusive philosophy of STEM believes that these transferable skills are useful for everyone and that a society educated in this way is therefore more successful because of these skills. This idea greatly inspires the motivation behind the goals and practices of Inclusive STEM education programs.

According to Bicer, Navruz, R. M. Capraro, M. M. Capraro (2014) there are three goals of inclusive STEM education. 1) to increase math and science test scores across the United States, 2) to increase representation of minorities in STEM positions, and 3) to grow a well equipped STEM workforce to compete in a global economy. These goals are nearly identical to the purpose of exclusive programs, the difference being their definition of success and their means of achieving that success. For instance, a selective STEM program may be more concerned with the number of its students who attained professions requiring a master's degree or above, while and inclusive program places greater emphasis on technical schools and bachelor's degrees. Bicer, et. al.(2014) clarify this point in their discussion of the objectives of inclusive STEM programs, "Although there is an effort to increase the number of students who pursue advanced STEM degrees, increasing the number of students who pursue the STEM related workforce (e. g., K-12 STEM teachers, computer and medical assistance, and nursing) is equally important for the nation's economic competitiveness in the global market" (p.10). As a whole inclusive STEM views our nation's challenges as comprehensive societal problem that requires better participation of all citizens in order to be successful.

There are dedicated inclusive STEM schools that do not base admission on testing and aptitude, but they are equally rare as their exclusive counterparts. Inclusive STEM more commonly presents itself as afterschool programs and integrated lessons emphasizing problem based learning (PBL) rather than traditional lecture based learning. Unlike exclusive programs that focus on developing students existing aptitudes for science and mathematics beginning in middle school, inclusive programs seek to develop an interest throughout a student's life through exploration and discovery.

While the emphasis of STEM education is still placed on secondary education, greater attention is now being paid to primary grades and early childhood.

Purpose of Study

The purpose of this study is to explore how STEM based curriculum integrated with the Social Emotional Learning (SEL) framework already in place can enhance learning and overall development in early childhood learners. Participants were preschoolers between the ages of 3-5 enrolled in a summer program. The following are the central research questions:

1. Can social emotional instruction be integrated with STEM with the same level of success as when it is taught independently?
2. Does the presence of SEL instruction integrated within STEM curricula improve the likelihood of students achievement of STEM learning objectives?

Methodology

Research Design

A mixed method approach was used for data collection. Once the child development center agreed to allow the study to be implemented, the IRB approval was obtained and the lesson plans to include STEM curriculum and state standards were developed. Parental consent forms explaining the study objectives and procedures were sent home to obtain parents or guardians approval. All consent forms sent were signed and returned. This study collected both **quantitative** and **qualitative** data. Quantitative data consisted of **scores recorded on rubrics**. Qualitative data was collected via **classroom observations** and random **informal interviews** with students. The teacher was also interviewed. The study used **control** and **experimental** groups and participants were **randomly** assigned into the groups. The control group followed the standard curriculum procedures already in place at the center. The experimental group included Science, Technology, Engineering, and Mathematics **(STEM)** learning activities, such as building bridges in small groups. Researchers then compared the assessment rubric scores to determine any difference between groups. Rubric includes observational measures such as if child used senses, materials or tools to investigate and expand their knowledge.

Population and Sampling Procedures

The research used a sample of convenience. Participants in this study included twenty-five (N=25) preschoolers ranging in age from 3-5 years old and included both male and female enrolled in a summer program offered at a Child Development Center at a midwestern mid sized university. The inclusion of early elementary children was crucial to this study because of its focus on improving learning conditions and overall development in early childhood education as outlined in the state's guidelines. A certified teacher (N=1)with over twenty years of teaching experience taught both control and experimental groups and all the lesson involved in the study.

Control Group Procedures

After students' morning recess (10:30 AM) control group participants entered the classroom and sat on the their group time rug. From there students were introduced to the lesson through either a story book or video as an anticipatory set. Once the content of the lesson was covered, they were given specific instructions for the days' project and were directed to begin building. Students were explicitly given no social emotional directions during this time and observations were made on their peer interactions. At the conclusion of the building period students tested their inventions each day and were asked to reflect on what they liked about their product and what they might do differently next time.

Experimental Group Procedures

At the conclusion of the control group lesson experimental group students enter the classroom and take a seat on the rug. This group of students receives the exact same lesson taught by the same teacher with the one exception being the addition of Social Emotional Learning content. During the lesson the teacher addresses common issues of working with a partner or small group and gives suggestions of how to overcome those obstacles. At the conclusion of this lesson experimental group students are given instructions on the days building activity and are reminded of SEL strategies for working with partners or small groups. When the building portion of the lesson is finished students test their inventions and are asked to reflect on the effectiveness of their invention and the possibility for improvement.

Qualitative Data Analysis

The data were obtained as recorded statements or responses by the study participants and were transcribed into a Microsoft Word file for analysis, which was conducted according to the general strategies proposed by Creswell (1998). The researcher reviewed participants' written responses to obtain the sense of overall data. After studying the recorded data, the researcher started the coding process. According to Stake (1995) and Creswell (1998), coding can be defined as the process of making a categorical aggregation of themes. An in vivo coding strategy was used. In vivo coding implies that each code comes from the exact words of the participants. Coding implies the process of grouping the evidence and labeling ideas. After coding was completed, the ideas were transformed into themes and sub-themes. The qualitative data are presented through visual graphs and findings were presented as an integral part of results and discussion as much as possible. After the study data were transcribed and analyzed, results are presented in the form of statements and tables.

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Study Limitations

The limited sample size and diversity (learning abilities, ethical and social background) among the participants available for the study makes it difficult to generalize the findings to other populations. Additionally, future research should include a wider range of pre-and post measures to gauge deeper insights into participants' learning gains.

Figure 1: Sample Lesson Plan with STEM Learning Objectives

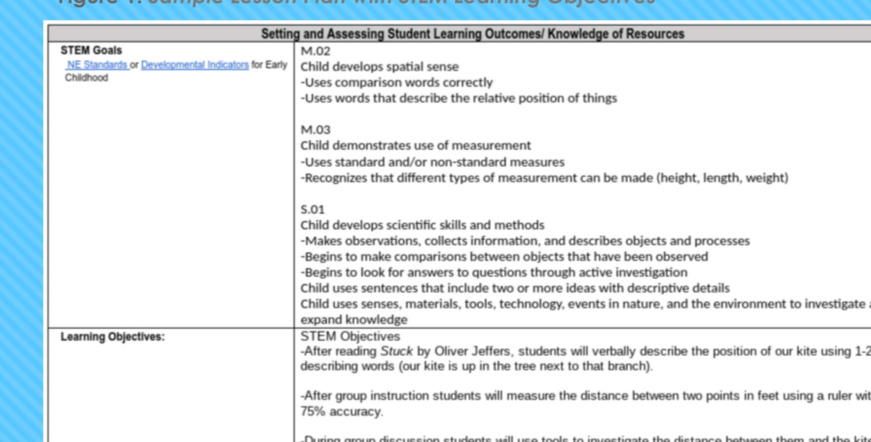
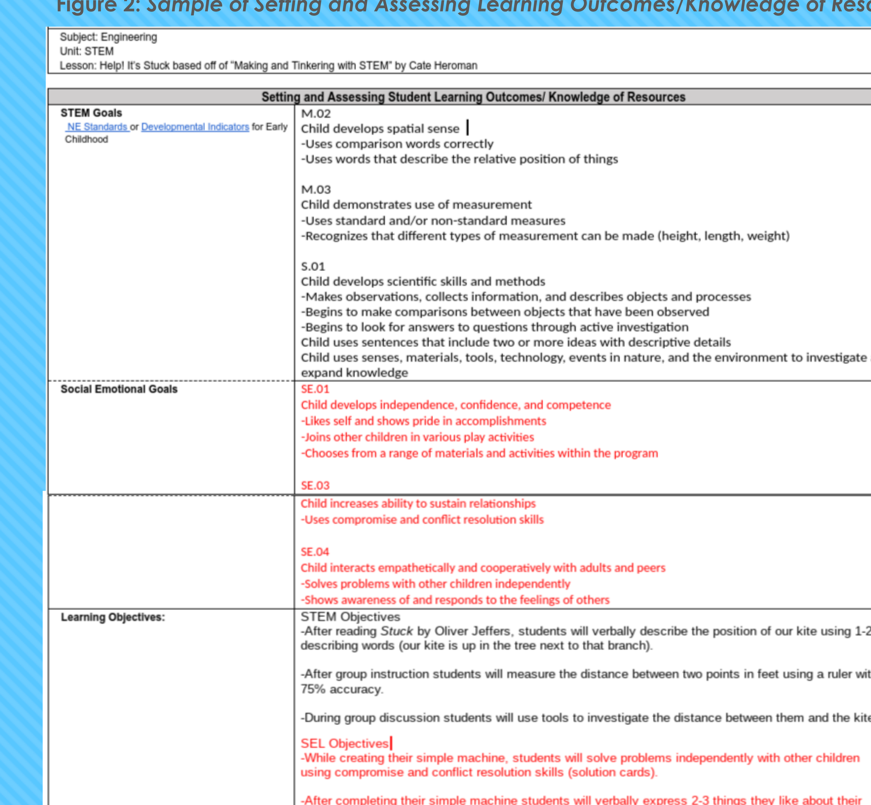


Figure 2: Sample of Setting and Assessing Learning Outcomes/Knowledge of Resources



Results

The charts show that the control group does require more Directions, did less Observations, and Comparisons than the control group. The charts are based on percentages instead of frequency to provide a relative view of the limited quantitative data generated by the rubrics. Statistically they are not significant due to the small sample size. The following charts are broken down by group (control v. experimental). The control group does have a higher numbers percentage wise for the three variables (Directions, Observe, and Comparison) than the experimental group. This means that visually, it appears the control group required more efforts on the three variables than the experimental group. This is a visual representation of the data. Statistically, there is no significant difference.

Discussion

While the findings were limited, the outcome of this study proved to be beneficial. Through the process of developing and implementing lessons and rubrics many practical lessons have been learned that may benefit future research. While our sample size was adequate for this pilot study, a larger more diverse group of participants will be necessary to collect meaningful data.

In future investigations more rigorous measures will be helpful for the purpose of gathering useful data. This initial study investigated students willingness to follow directions, respect towards others, their ability to compare and contrast pieces of information, and observation skills. In time it was found that while these topics were useful and interesting both in the context of STEM and SEL, they were difficult to quantify and largely to broad. Subsequent studies will therefore need to focus on the development of more specific measures that will accurately portray student growth.

Additionally, the importance of taking time to develop students understanding of the problem solving process became abundantly clear. From day to day it was apparent that students were becoming more open to thinking critically about the problems presented to them, but struggled to do so in a consistent matter. When students were asked to reflect about an aspect of the problem solving process discussed from the day before, it was apparent that further time was needed to help students develop an understanding of this process. Practically, this pointed to the fact that STEM activities will require a significant amount of time to implement, especially when working with young learners.

The most interesting aspects of this research were found in the details of each lesson by simply observing what did and did not work in respect to engaging students and managing classroom behaviour. In early lesson students were given a large and diverse range of building materials to choose from for the purpose of promoting creativity. Interestingly instead of promoting creativity the abundant options proved to be both overwhelming and distracting leading to less creativity and more off task and problem behaviours. In later lessons the material lists were refined to suit each individual lesson which resulted in greater student interest and creativity. This study has practical implications for classroom teachers interested in integrating STEM. For example, organizing material lists, extending time spent on STEM activity procedures, and implementation of differentiated of instruction. These are critical areas that will need particular attention when fully implementing STEM curriculum with early childhood learners.

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Data Analysis

Table 1: Sample STEM Lesson

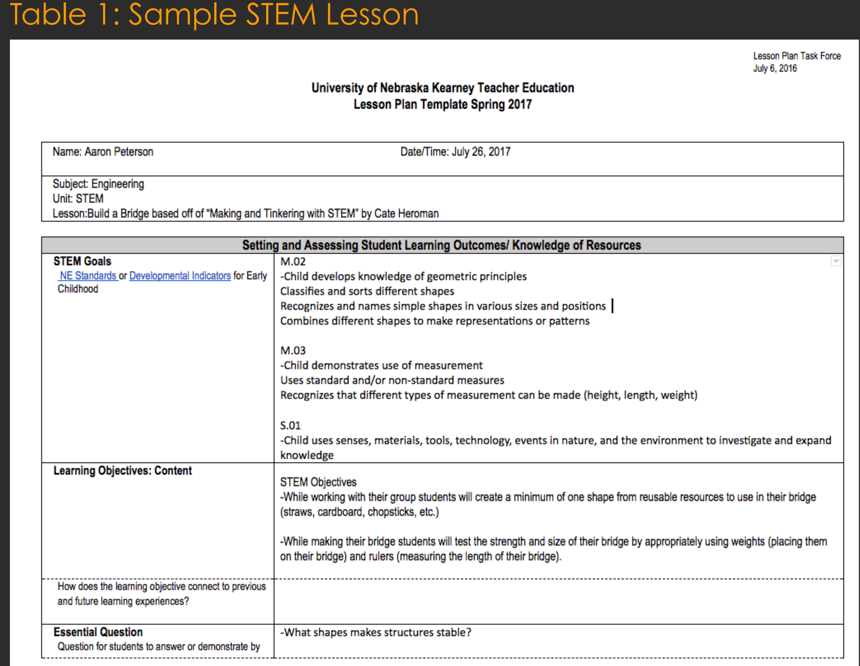

Table 2: Sample Qualitative Data

Excitement	Confusion	Problem Solving	Frustration
• Because we think it will work and if not we'll try it again • I did it! • This will be the best ever! • I made a drum! • Mine is perfect! • That's a fun video • Look at mine! • I like how it raddles!	• What do we have to do? • What do I need? • What do I do with this tape? • I can't do it! • I don't remember	• Buy a back scratcher • Get another person to scratch your back • A solution is where you draw a picture and then make something • The first step is to ask a question • A prediction is saying yes or no to something. If it will go up or down before you test it • Engineers work together to make things better	• She didn't help me at all • I don't like this story • No one will help me • Why didn't you help me? • Don't take others' things • No, we didn't have any ideas • I can't make it • He can't change the boat , it's mine

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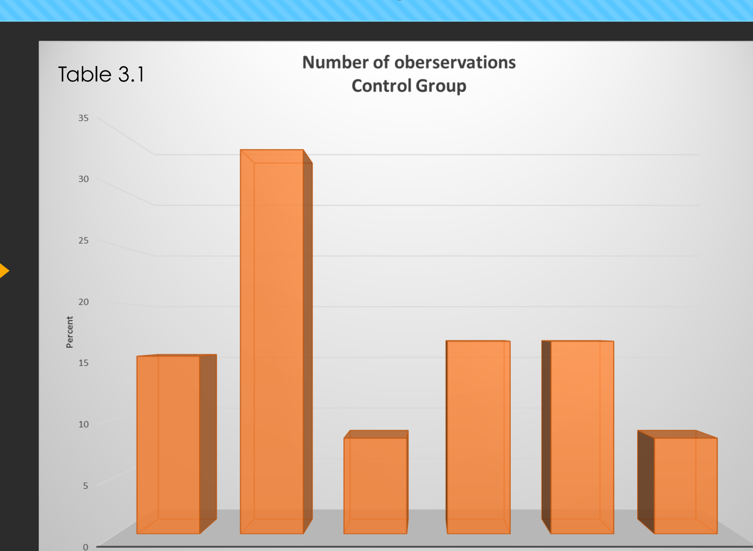
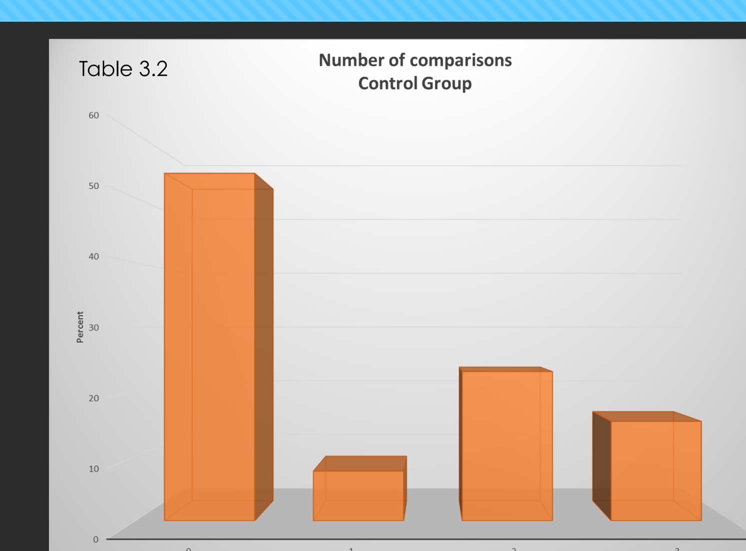
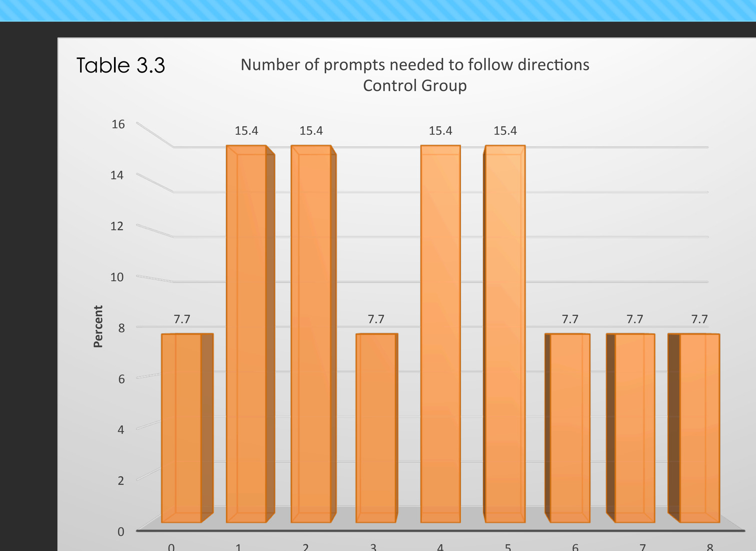
Control Group







Experimental Group