5-10-2021

STEM Education in the Early Childhood Classroom

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Submitted in Partial Completion of the
Requirements for Departmental Honors in Early Childhood Education

Bridgewater State University

May 10, 2021

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Recognition

Thank you to the Bridgewater State University Honors Program for allowing me the space and opportunity to pursue research about a topic I am passionate about. Thank you for also giving me the chance to share my findings with others both at Bridgewater State University and at outside conferences.

Thank you to the Department of Elementary and Early Childhood Education at Bridgewater State University for providing me the opportunity to ask questions and dive deeper into my education courses.

Thank you to Dr. Heather Pacheco-Guffrey for encouraging me every step of the way and taking time out of your day each week to help me achieve my research goals and teaching me all about how to properly conduct a research study.

Abstract

This qualitative study focuses on the type of STEM education students are getting at the early childhood level (PK-2). Based on gaps found in literature, an interview protocol was created and six participants with various careers in the field of STEM education were interviewed. The research was concentrated on trying to determine what components of STEM education make it successful in the early childhood classroom. All of the interview responses were analyzed and coded and determined the results found below. A few integral parts of a successful STEM education seem to be curiosity, asking questions and a hands-on component, but this research is very limited and there is still a great amount to explore and investigate.

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Introduction

As an elementary student, the best part of the week was when I would get to explore in a science lesson and do problem solving, and I always wondered why it was not done more. I am a senior at Bridgewater State University double majoring in Early Childhood Education and Earth Sciences with a minor in TESOL (teaching English as a second/other language). As a double major in Early Childhood Education and Earth Sciences I have always been intrigued about how the two fields intersect. During various observation hours and time spent in early childhood classrooms as a substitute teacher, I have seen how STEM is implemented (or not) in numerous classrooms. In seeing this and through the conversations I have had with various teachers about the topic, I decided to do some more in-depth research on a topic that is, frankly, not very well-researched. This is a topic I am very invested in because of my connection to both fields but it is also a topic I believe should have more literature and research available about it. When I discovered how little there was specifically about successful STEM education in the early childhood classroom and what makes it successful, I decided this was the direction I needed to go. All this research was done during the pandemic, which means there was a lot of technology used throughout the entire process.

Literature Review

STEM stands for Science, Technology, Engineering and Math. The idea of the STEM curriculum is to allow there to be a fusion of each topic instead of teaching all of them separately since there are many similarities between those content areas. By teaching all four STEM fields as a cohesive unit, teachers are able to relate instruction to real world scenarios (Live Science, 2014). It is imperative to teach these four disciplines together and integrate them into the curriculum instead of individually as it removes boundaries and allows for more to be taught (Kalolo, 2016). STEM instruction is a time in the classroom where students are able to immerse themselves in creativity and real-world problems.

Research to improve STEM education has been in the media of late, but much of the focus is on the later grades and less on the younger ones (Milgrom-Elcott, 2019). When people are asked about when to start teaching STEM in the classroom, many people say middle or high school and the people that do believe it should start in elementary school say sometime around 3rd grade (Hand, 2017).

STEM education is important to be taught at the secondary level (Gr 6-12), because it allows students the opportunity to work in a group setting as well as discover how some problems can have multiple solutions that have advantages and disadvantages (Capraro & Slough, 2013). By teaching STEM at the secondary level, students are becoming critical thinkers before they graduate and engage in post-secondary studies to help them better succeed (Capraro & Slough, 2013). Their knowledge of how to use their curiosity in the fields of STEM helps improve their post-

secondary education experience as well as their employment readiness level (Icel & Davis, 2018).

When examining research about STEM education at the secondary level, three important themes emerge: (1) STEM careers; (2) offering STEM internships or experiences at colleges or universities; and (3) engaging students in authentic hands-on STEM experiences (Christensen et al., 2017). One component that should be emphasized when STEM is taught at the secondary level is the idea of careers in the various fields and what can be accomplished by pursuing a career in one of the STEM fields (Kasza & Slater, 2017). It is also important to allow learning experiences for these students in the real world in the forms of STEM internships (Erdogen & Stuessy, 2015). Additionally, hands-on experiences help students develop a positive attitude about STEM in general and encourage them to pursue a degree in one of the STEM fields (Christensen, Knezek & Tyler-Wood, 2015; Erdogen & Stuessy, 2015). At the secondary education levels, students are also receiving a more rigorous and challenging course load to prepare “for post-secondary education and employment” (Live Science, 2014). In secondary education, students need to be taught how to use their curiosity and apply it in the areas of STEM (Icel & Davis, 2018).

In the elementary grades it is important to teach STEM because it is imperative to build foundational skills so grade by grade concepts can be built upon (NRC, 2012). NGSS has set forth benchmarks (standards) for each grade level and these are what the Massachusetts standards are based on. For students to be able to achieve these grade-level standards, it is imperative for students to begin “thinking and acting like scientists and engineers...in the elementary grades” (Aaron, 2017).

At the elementary level (Grades 1-6), the aspects of STEM education that are important to implement are (1) introducing what STEM is, (2) STEM careers, (3) collaboration, (4) hands-on learning (Kasza & Slater, 2017; Live Science, 2014). In elementary school, the focus is on introducing what STEM is and the different jobs that involve STEM or are in any fields relating to those content areas. There is also a focus on bridging all four of the content areas and “pique students’ interest” in engaging in those areas (Live Science, 2014). For young children to want to be involved in STEM areas it is imperative teachers emphasize how it is an area where they will be very hands-on (Gomez & Albrecht, 2014).

Elementary and secondary approaches to STEM education address similar concepts in different ways. When looking at secondary education and elementary education, information about STEM careers is being taught but in different ways. In both the younger and older grades, students are learning about what careers you can pursue in the STEM fields. At the secondary level, however, students are receiving more opportunities to engage in internships and experiences in those fields to see if it is something they would enjoy. Elementary STEM education is focusing a lot on the collaboration component and allowing and teaching students to work together. Secondary and elementary students both engage in hands-on learning to help them develop a more positive mindset about STEM and enjoy themselves more. The younger grades are learning more surface level information about STEM and exploring some real-world scenarios while the upper grades are exploring how they can use these skills in a future career.

It is positive that districts and teachers are able to implement STEM in the younger classrooms, but children have a much greater capacity to learn STEM at a young age than simply being introduced to what it is. Researchers have discovered that children are learning more about their world than they always show outwardly; they have discovered that both the learning and development of children is more rapid and is also cumulative and ensures a solid foundation for the future (NRC, 2015). Research has also shown that the brain is more responsive to learning math and logic between the ages of 1 and 4 and developing math skills early in life predicts their later learning (Hand, 2017). Learning STEM at a young age also helps improve their abilities in subjects that are not STEM related such as language-learning, executive function and literacy (Hand, 2017).

There is not much literature on successful STEM programs in Early Childhood Education (PK-2). The literature there is, emphasizes that teaching STEM in Early Childhood classrooms is an effective way to integrate varying subjects, such as language and literacy (Tippett & Milford, 2017; Buchter et al., 2017). In early childhood education, there is the knowledge that it is important to teach science and take advantage of their natural curiosity, but this knowledge does not extend to the other three areas of STEM (Milford & Tippett, 2015). Although there is not much literature about STEM programs in Early Childhood, the articles out there agree that it is something that should be implemented to take advantage of young curiosity and their want to explore everything around them (Buchter et al., 2017; McCure et al., 2017; Milford & Tippett, 2015; Tippett & Milford, 2017).

However, from what we can observe from the literature it is imperative that STEM education begins early. At a young age, children's brains are more responsive to learning these areas and it also improves their abilities in other areas (Hand, 2017). Children also are learning more that they show and the development of children is more rapid than people may believe (NRC, 2015). This study seeks to understand what makes successful STEM education in Early Childhood.

Methods

This section describes the methods for this qualitative, interview-based study. This study is designed to answer the following research question: What does successful STEM education look like in the Early Childhood classroom?

Participants

Participants were recruited from a range of STEM education positions. I recruited from a pool of educators in a wide range of roles in STEM education who were known to my thesis advisor as well as a University faculty member who authored several resources I used for the literature review. See Table 1 below for details about each participant. The gender of all the participants matches their pseudonyms, David was the only male participant in the study.

Table 1

Participant Pseudonyms of Study Participants and Their Roles

Participant Pseudonym	Role in STEM Education
Marie	STEM Education faculty/researcher at large Ph.D. granting University
Sue	Elementary math and science curriculum coordinator for large urban district in New England
Linda	Director of the STEM Education Center at a large state University in New England
David	STEM Education consultant for program and material redesign, and professional development
Sophie	Former PK/Kindergarten teacher (30 years) and currently working in education publishing
Abby	Second grade general education teacher in an inclusion classroom working under an initial license

Materials

The materials for this study included the interview protocol developed specifically for this study (Appendix A), letter of invitation (Appendix B), and informed consent (Appendix C) as well as Zoom video conferencing software. Due to the COVID-19 pandemic restrictions, all correspondences including the interview were conducted with technology support for remote communications.

- University Microsoft Outlook account: used for email correspondence with all the participants where they received an invitation to participate along with a recruitment letter and once they had agreed to participate were sent the Informed Consent document.
- University provided Zoom account: used to conduct interviews and secure consent
- Otter.ai: used to transcribe interviews.
- University Microsoft Stream account: used to store participant videos. Secure, password protected server.
- University provided GSuite account: used to store the transcripts of the participants responses and for data collection and analysis.

Procedure

Literature Review. The first part of my research consisted of researching articles to put together a literature review. I used certain phrases to find literature that would fit my needs. The phrases I used are in Table 2 below. The literature review revealed differences and similarities in elementary and secondary approaches to STEM Education so this is how I structured the literature review. I created an interview

protocol based on gaps I found in the literature about STEM in Early Childhood education.

Table 2

Search Phrases Used for Finding Research for the Literature Review

Search Phrases for Literature Review
what is STEM success indicators in early childhood
what makes a successful STEM lesson
successful implementation of stem education
successful STEM
how to have a successful STEM program
characteristics of a successful STEM program
why is it important to teach STEM in secondary ed
why STEM in elementary
hands-on STEM in secondary ed
curiosity in stem in secondary education
STEM hands-on learning elementary education
STEM in early childhood education

Instrument. An interview protocol was developed to capture participants' perspectives on the role of STEM in Early Childhood Education. Invitation, informed consent and recruitment documents were also generated for this study. The interview protocol (Appendix A) consisted of ten questions, the first five of which were background questions before diving into the questions that were later analyzed. The questions were:

1. What is your name?
2. In what capacity do you work in STEM education?

3. What is your experience with STEM education?
4. What is your experience with STEM in early childhood?
5. What drew you to STEM education?
6. What are opportunities and challenges with implementing STEM education in early childhood? (lesson planning, curricular resources, materials, logistics)
7. What does successful STEM education look like in early childhood?
8. How do you know it was successful?
9. Why teach STEM in early childhood?
10. What do you want students to get out of their STEM education?

Decisions About Participants and Recruitment. After the interview protocol was created, I determined who to interview that would provide me with the insight I wanted along a spectrum of professions pertaining to STEM education. Since there is little research about STEM in Early Childhood, I wanted to have as broad a spectrum of participants as possible. Most of the research available has been with early childhood educators so I was curious to see not just what teachers believe but what people who are creating the curriculum, both on a smaller scale (like curriculum coordinator) or on a larger scale (like the participant who worked for the state creating frameworks). By having a broader range of participants I researched, I believed it would provide me a more overall view of STEM in Early Childhood as opposed to simply people telling me their experiences at that level. Before I was able to send out any invitations, I completed and was approved for an IRB since there were human participants in the research.

The same invitation email and recruitment letter was sent to each prospective participant with the invitation asking them to participate and the recruitment letter providing more details about the study and requesting they respond by a certain date.

Once the participants replied in the affirmative, a subsequent email was sent thanking them for their willingness to participate and with the informed consent

document attached, which outlined exactly what they would be agreeing to by saying they would be a part of the research. Since this study was conducted during the global pandemic, all of the interviews were conducted via Zoom instead of face to face. Additionally, instead of having participants provide informed consent in writing, they provided it verbally at the beginning of the recorded Zoom interview as per advice of the BSU IRB committee. As the interview was done through Zoom, I was also fortunate in that I was able to have participants from out of state to expand the range of participants.

Analysis. Analysis for this qualitative study was conducted through open coding (Benaquisto, 2008). I did not know what kinds of codes would emerge from the data so I used a grounded theory approach (Glazer & Strauss, 1967). As I worked through my coding process, I engaged in the constant comparison method (Glaser & Strauss, 1967) to analyze my findings and to enable me to make sense of my data. After coding responses to the interview questions from the six participants of the study, I generated the results below.

Results

Introduction

The interview protocol consists of 10 questions, the first five of which include background questions about participants and their connection to STEM and specifically to STEM education. For the analysis of the research, I coded participant responses to the latter five questions which probed participant ideas and perspectives. The questions I coded were:

6. What are opportunities and challenges with implementing STEM education in early childhood? (lesson planning, curricular resources, materials, logistics)

7. What does successful STEM education look like in early childhood?

8. How do you know it was successful?

9. Why teach STEM in early childhood?

10. What do you want students to get out of their STEM education?

The results reported below are organized by the questions and themes that emerged from this research. There were ten themes that emerged, with the final theme of asking questions being a recurring theme discussed in multiple questions. Many of the themes also had sub themes as well. The themes, in order, with their sub themes in parenthesis, are: **curiosity** ((1)taking advantage of young curiosity and (2) helping curiosity extend outside of school), **more interest** ((1)teacher's enthusiasm and (2) building foundational skills), **foundation for the future** (different world now), **improve the world around them** (fixing world issues), **teachers as an asset** (chance to get

creative and make instruction meaningful), t**eachers as a challenge** ((1) teacher attitude and (2) knowledge of content), **system of education** (amount of content needing to be taught), **inquiry/question based learning and curiosity** ((1) asking questions (2) curiosity and (3) independence), **hands-on learning,** and **asking questions** ((1) continuing to ask questions (2) wondering how things work (3) having the tools to ask questions and (4) having a worldly view).

There were six participants in this study. Three of them work directly with schools and children while the other three are slightly removed from working directly with schools and children. In coding their responses, it was interesting to see how the proximity to children and schools affected the answers they gave. The table of participants is below (Table 1) for reference while reading through this section.

Table 1

Participant Pseudonyms of Study Participants and Their Roles

Participant Pseudonym	Role in STEM Education
Marie	STEM Education faculty/researcher at large Ph.D. granting University
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Reasons for Teaching STEM in Early Childhood Education

In response to an interview question about why teach STEM in early childhood education, the participants answered with 3 themes: (1) curiosity, (2) more interest, and (3) foundation for future. Two participants, Sue and David also identified STEM Ed as an important place for integrating other domains into STEM education. David points out:

> But also it's [STEM education in early childhood] an awesome way to bring in literacy, social science, art, it forms, the often the kind of the subject material for getting into other mechanics and other things that they're supposed to be learning along the way.

Curiosity

When participants talked about curiosity, they brought up two different subthemes: (1) taking advantage of their young curiosity and (2) helping their curiosity extend outside of school. Two participants, Sue and Linda, brought up the fact that it is important to take advantage of the young curiosity that is in students at the early childhood level. Sue, a STEM district coordinator, shared her views on the importance of teaching STEM in Early Childhood education, “especially at the early childhood, because you're taking kids natural, inquisitive beings. And you're saying that's great that you have so many questions, let's explore them." Marie and Linda talked about how they want students' curiosity to extend outside of school and realizing they can use this information in real world settings. Marie said, "just start to get students to think about sciences more than just something you do in school.

More Interest

When participants talked about helping students gain more interest in the subjects, they identified two different subthemes: (1) the teacher's enthusiasm and (2)

building foundational skills. Two participants, Marie and Abby, talked about how important it is for the students to be able to see the enthusiasm the teachers have for this topic and how that can have a ripple effect on the students. Marie said:

> That I'm hoping that if we can get the teachers to start doing this more on a regular basis, the students start seeing you asking questions, being interested. And then you know, everything else that I said that we keep those interests and those identities for a longer period of time.

Sue and Abby also identified that it is important for students to gain the interest and foundational skills at a young age to help them as they progress in their schooling. Abby said, "And it'll get their brain thinking in that mathematical computational way that will prepare them for when they actually start like delving into the specifics when they're in that older grades."

Foundation for the Future

When participants talked about wanting to help create a foundation for these students' future a subtheme that arose was how different the world is now than it ever has been which makes it more critical for these students. Abby said, "..., with students needing these skills [STEM] more than we needed when we were in elementary school, we really need to prepare them for their future."

Student Benefits

In response to an interview question about what they want students to get out of their STEM education, the participants answered with 2 themes: (1) to improve the world around them and (2) to ask questions.

Improving the World

When participants talked about the students improving the world around them, the subtheme three participants brought up was fixing world issues. Abby said:

> And with global warming and all of the different issues that are going on, I want them to look at something and not say, Well, I can't do anything about that. I want them to think about how they play a role in their community and their environment and how they can make the world a better place.

Another participant, Marie, said:

> We need people to go in medicine, we need people to solve these like huge world problems. And I think that's another like, really big picture lofty goal that people who are in like STEM education and STEM education, research, really hope, like, all this work will end up like, helping to solve those problems.

Opportunities and Challenges of STEM Ed in Early Childhood

In response to a question about the opportunities and challenges of teaching STEM in early childhood education, participants responded with one theme about opportunities and two about challenges. This question was where the roles of the participants were noticed most in how they answered it, with the participants who worked in close proximity to schools and children answering one way and participants who were farther removed from schools and children answering another way.

Opportunities

Sophie and Abby, both teachers, were the only participants who addressed the opportunities of STEM Education in Early Childhood schooling before the challenges. They, along with Sue who also works directly with schools, identified teachers

themselves as part of “opportunities” in STEM education. They shared that teachers have the chance to get creative and make it a meaningful experience for the students. Abby said, "So you can get creative with it and kind of work around those cons." While Sue said, "teachers really love to teach it...to be able to implement it and in a way that is meaningful for the students." All three of the participants who work in close proximity to schools, Sue, Sophie and Abby, were the three participants who remarked on the idea that teachers are in fact an opportunity when teaching STEM at the early childhood level.

Challenges

When talking about challenges of teaching STEM in the early childhood classroom, one theme that emerged was the teachers themselves. In this theme there were two subthemes that emerged: (1) teacher attitude and (2) knowledge of content. All three participants (50% of participants) who talked about how teachers were a challenge when implementing STEM in the early childhood classroom did not work in a public school system, Marie, Linda and David. Marie said, "So already, there's like, these negative attitudes to and I think that's kind of this additional barrier." Linda also remarked, "And it's something that's done sort of when they have time and not always sort of the central focus".

When talking about challenges of teaching STEM in the early childhood classroom another theme that emerged was the system of education. The aspect of the system of education that participants critiqued was the amount of content that needs to be taught. Sue said, "You're trying to make sure that you attend to their literacy skills, that they're those needs, that their mathematics, their social, emotional, you know, all of

these things all trying to fit in one day." While Linda pointed out, "There's so many topics that need to be covered."

Successful STEM Ed in Early Childhood

In response to an interview question about what makes for successful STEM Education in Early Childhood, participants responded with two themes: (1) Inquiry / question-based learning & curiosity and (2) hands-on learning.

Inquiry/question-based learning

When participants discussed inquiry / question-based learning, they identified three subthemes about students: (1) asking questions; (2) curiosity; and (3) independence. Four participants, Marie, Linda, David and Sophie, talked about the importance of children asking questions as part of their learning. Linda pointed out "...some of the first things that little kids ask... are ...why? how?" Linda and David mentioned curiosity as an important component of successful STEM education programs. Linda also said, "kids are curious, right and naturally curious. They want to know how the world works...". They talked about the importance of STEM Education programs working to maintain children's natural curiosity. An interesting point brought up by Sophie that is important to note is the relationship to inquiry/question-based learning and play especially when thinking about younger children. Sophie remarked:

> I would say a successful STEM education is, is a balanced approach between sort of exploration, kids need to explore and play, you know, they need to be able to take their own initiative and act on their own sort of thoughts and ideas and questions.

Here she is emphasizing that for children in early childhood (PK-2) one way that they explore and inquire is through play, which is an important idea to bring up.

Hands-On Learning

Two-thirds of participants identified hands-on / experiential learning as one of the key components that makes STEM learning experiences successful. Three of them work directly with public schools, Sue, Sophie and Abby. Sue said, “And they're anchored in phenomenon. They are really inquiry based; it is hands on is exploratory.” While Marie shared, "...especially early childhood [successful STEM integration] means the class is probably loud, it's messy. The kids are moving about.”

Ask Questions

A recurring theme that was talked about in response to different questions was the idea of students asking questions while they are learning and then continuing to ask questions once they have finished. This was a theme that was talked about explicitly in two questions, question eight which asks about how they knew STEM was successful and question ten about what they want students to get out of their STEM education. In question seven about what makes for a successful STEM lesson, questions again came up but in a slightly different capacity, as inquiry or question-based learning instead of explicitly as asking questions.

The sole theme for question eight about how they know if STEM was successful was asking questions. When participants talked about asking questions, they identified two subthemes about students: (1) continuing to ask questions and (2) wondering how things work. Marie, Linda and David talked about the importance of students continuing to ask questions after the lesson was done. Marie said, "I think it would be that the

students don't stop asking question...those students...continue asking questions continue being curious." Two participants, Sue and David, talked about how it is important for students to be able to keep wondering how the world around them works. David said, "kids want to still inquire about how the world works and how things are built. And they continue to ask questions about the world".

In question ten, one of the two themes participants identified about what participants want students to get out of their STEM education was asking questions. When participants talked about asking questions, they identified two subthemes about students: (1) having the tools to ask questions and (2) having a worldly view. Sue, Linda and David talked about wanting the students to have the tools to ask questions. Sue emphasized, "I would want people ... to know how to ask good questions. I don't expect everybody to know everything about every science topic. I don't. I would want students to know how to ask questions,".

Sue, Sophie and Abby, who are the three participants who work in close proximity to schools, also talked about how they want students to use this skill of asking questions when thinking about the world around them. Sue, a curriculum coordinator said, "...I want them to be inquisitive enough to want to know how things work, I want them to be inquisitive to know about the world around them."

Conclusions

Limitations

This study interviewed a cross section of educators in STEM, with only 1-2 people representing each role in STEM education. The sample size of the study was also small, with only six total participants. Since the sample size was small, there was not able to be as wide of a range in terms of all the different areas of STEM, more were science and math as opposed to being able to have participants who specialized in the areas of engineering and technology. Most of the educators in the study were from the Northeast. All findings should be accepted with caution due to the limitations above.

Introduction

This section describes the conclusions that were found for this qualitative, interview-based study. These conclusions were drawn in answer to the following research question: What does successful STEM education look like in the Early Childhood classroom? Based on this research, the following seem to help create successful STEM education in the Early Childhood:

1. Encouraging students to continuously ask questions
2. Capitalizing upon children's curiosity
3. Hands-on learning
4. Creative and resourceful teachers

Conclusions From Study

Since STEM education is based in asking and answering questions it is important to continue to push students to ask questions. It is imperative to provide students with the tools to ask these questions and allow them to keep asking the why or how questions. The students continuing to ask questions after the lesson is over is proof that STEM education was implemented correctly. The most important takeaway from a successful STEM lesson is if the students can and do continue to ask questions.

Curiosity should be fostered, and children's questions should be invited into the classroom space. It is important to acknowledge students' questions and push them to investigate and find an answer to them, even if there is not time to do it as a class. Young children are naturally curious and by allowing them to be the primary investigators of their own questions, they will be more engaged and enjoy themselves in a greater capacity. By showing them it is okay to ask questions and in fact that is what you want them to do, students will want to keep asking deeper and more difficult questions and will be engaging in aspects of STEM they are not even aware of. They can become scientists investigating phenomena they did not even know existed, or engineers investigating why their house with toothpicks and marshmallows does not stand up. STEM education is based in asking and answering questions so it is important to foster this curiosity in the youngest of students engaging in STEM.

Hands-on learning, learning in which students are actively engaged using part of their body to learn, was identified as critical to successful STEM education programs in early childhood education. Be it through play or experiential learning, allowing students to have hands-on experiences is how STEM education will be successful in an early

childhood classroom. Allowing students the hands-on opportunities in their STEM education will help ensure they are fully immersed in the lesson and the goals of the lesson can be achieved to make it a successful lesson.

Since STEM education is based in asking and answering questions it is important to continue to push students to ask questions. It is imperative to provide students with the tools to ask these questions and allow them to keep asking the why or how questions. The students continuing to ask questions after the lesson is over is proof that STEM education was implemented correctly.

It appears that the view of teachers' impact on STEM education in Early Childhood can be linked to the role of the viewer. In this study, teachers were viewed as an asset by people working directly with schools. However, teachers were viewed as an obstacle by people who worked indirectly with schools.

Relation to Literature

There is so much literature about secondary and elementary that talks about authenticity and curiosity in successful STEM education and findings from this study suggest they are central in Early Childhood Education as well. Research talks about how it is important to take advantage of young children’s natural curiosity (Milford & Tippett, 2015) and participants in the study also believed the same thing. Sue, a STEM district coordinator, even directly referred to children’s natural curiosity at such a young age saying, “especially at the early childhood, because you're taking kids natural, inquisitive beings. And you're saying that's great that you have so many questions, let's explore them." This was an area where similarities were seen in both the literature and in interview.

Implications

As a future teacher it is important for me to ensure all my STEM lessons have a hands-on component to allow my students the highest level of learning. In finding out the importance of fostering the students' curiosity and continual questions, I will need to focus on both tying in questions students ask into the STEM lessons and creating an environment where it is encouraged that they ask questions and find ways to investigate them. A goal I will need to work towards is ensuring my students have the tools to ask questions and ensuring I am modeling asking questions myself to allow them the experience of seeing it done. I need to be aware that different people may have a range of perceptions about the role of teachers in successful STEM Education in Early Childhood. I will seek to bring creative and resourceful ideas into my classroom both through professional development and social media so I can be an asset to successful STEM education for my students.

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Appendices

Appendix A

Interview Protocol

Good morning/afternoon/evening, thank you for taking the time out of your day to meet with me and answer some questions. My name is Julia Biagiotti and I am the student researcher on this project, where I am looking specifically at early childhood education and the STEM education students reach at their level in their schooling.

IRB Consent Process:

In a moment I will ask for your verbal consent.

Before I ask for your verbal content,

1. Do you have any questions about this study based on what you read in the informed consent document? Do you have any other questions?
2. Please be sure of the following:

· you have read this consent form (or it has been read to you) and have been given the opportunity to ask questions and have them answered;
· you have been informed of potential risks and they have been explained to your satisfaction;
· you understand that Bridgewater State University has no funds set aside for any injuries you might receive as a result of participating in this study;
· you are 18 years of age or older;
· you are aware that your participation in this research is completely voluntary;
· you are aware that this interview will be recorded on my personal laptop and that the video file will be removed from my laptop and transferred to a secure storage server within a week;
· you are aware that you may leave the study at any time; if you decide to stop participating in the study, there will be no penalty to you and you may choose whether I retain or destroy your video footage and any data collected during the interview.

Do I have your verbal consent to participate in this study? Please state your name and provide consent if you are willing.

Start Interview Questions:

Great! Just to remind you, there are 10 questions and all I ask is that you answer these as completely as you can and in the best way you can based on your role in the STEM world.

1. What is your name?
2. In what capacity do you work in STEM education?
3. What is your experience with STEM education?
4. What is your experience with STEM in early childhood?
5. What drew you to STEM education?
6. What are opportunities and challenges with implementing STEM education in early childhood? (lesson planning, curricular resources, materials, logistics)
7. What does successful STEM education look like in early childhood?
8. How do you know it was successful?
9. Why teach STEM in early childhood?
10. What do you want students to get out of their STEM education?

Appendix B

Recruitment Letter

Participant name,

I am a senior at Bridgewater State University studying Early Childhood Education and Earth Sciences. I am doing research about STEM in Early Childhood education. I am interested in learning about the ideas and experiences of professionals all throughout the system of STEM education.

One way I want to do research is through interviewing professionals with a strong connection to STEM to give me insight from their perspectives. I would love to have the opportunity to ask you questions on this topic. The interview consists of 10 questions about your experiences in STEM and perspectives on STEM in Early Childhood Education. I will work around your calendar to schedule an interview through Zoom video conferencing software.

My findings will be presented at my university and the National Conferences on Undergraduate Research (NCUR) in Spring 2021. The interview is estimated to take approximately 20 minutes and will be recorded. We do not anticipate that you will experience any harm by participating in this interview. No identifying information will be shared when I present my findings, so your identity will remain confidential.

My work is under the mentorship of Dr. Heather Pacheco-Guffrey. You may contact her at hpachecoguffrey@bridgew.edu or me at jbiagiotti@student.bridgew.edu if you would like more information or if you have any questions.

If you are willing to be interviewed please reply to this email by (two weeks from sent date). I will then send you the informed consent form and start the process of scheduling your interview.

Thank you for your help,

Julia Biagiotti

Appendix C

Bridgewater State University Adult Consent Document

Title of Research: STEM in the Early Childhood Classroom
Researchers: Dr. Heather Pacheco-Guffrey, Elementary and Early Childhood Education, hpachecoguffrey@bridgew.edu
Co-researcher: Julia Biagiotti, jbiagiotti@student.bridgew.edu

You are being asked by a Bridgewater State University researcher to participate in a study. For you to be able to make an informed decision about whether you want to participate in this project, you should understand what the research is about, as well as the possible risks and benefits. This process is known as informed consent. This document describes the purpose, procedures, possible benefits, and risks of the research project. It also explains how your personal information will be used and protected. Once you have read this form and your questions about the study are answered, you will be asked to sign it. This will allow your participation in this study. You should receive a copy of this document to take with you.

Your participation is voluntary. You may decide not to participate in this study. If you do participate, you may withdraw from the study at any time. Your decision not to take part or to withdraw will involve no penalty or loss of benefits to which you are otherwise entitled.

Summary of Study

The purpose of this research study is to find out about STEM education in early childhood classrooms. You will be asked to answer 10 interview questions. Your participation in this study will last approximately 20 minutes. This study will help investigators understand more about how STEM is implemented in the early childhood classroom.

Explanation of Study

This study is being done because I want to find out about what STEM is like in the Early Childhood Classroom and how it can be implemented. In scientific literature there is not much information about STEM education at the early childhood level, so this study aims to supplement that literature.

If you agree to participate, you will be asked to complete an interview over Zoom and answer 10 questions. This Zoom interview will be recorded using my personal laptop. Video files will be removed from my personal computer and transferred to a secure password protected server within a week of completing the interview.

Your participation in the study will last the one interview call, no longer than 20 minutes.

Risks and Discomforts

There are no known risks to participants.

Can I stop being in the study?

You can stop being in this research study at any time. Leaving the study will not result in loss of benefits to which you are otherwise entitled. Tell the study staff if you are thinking about stopping or decide to stop.

If you decide to stop you can decide whether any of your data will be included.

Benefits

This study is important to science/society because it will show a cross section of STEM education through the lenses of many people who were involved in it. This contributes to the understanding of what these experts perceive are the important aspects of STEM in the early childhood classroom which is missing from the literature. STEM education in the early childhood classroom is critical moving forward, which makes this research important and insightful.

You may not personally benefit by participating in this study.

Confidentiality: How will information about me be protected?

Your study information will be kept confidential by being stored in server and computer that are secure and password protected.

While every effort will be made to keep your study-related information confidential, there may be circumstances where this information must be shared with:

* Federal agencies, for example the Office of Human Research Protections, whose responsibility is to protect human subjects in research;

* Representatives of Bridgewater State University, including the Institutional Review Board, a committee that oversees the research at BSU

Compensation

No compensation will be provided.

Future Use Statement

Identifiers might be removed from data/samples collected, and after such removal, the data/samples may be used for future research studies or distributed to another investigator for future research studies without additional informed consent from you or your legally authorized representative.

Contact Information

If you have any questions regarding this study, please contact the investigator Dr. Heather Pacheco-Guffrey, hpachecoguffrey@bridgew.edu

If you have any questions regarding your rights as a research participant, please contact BSU Institutional Review Board: Maxwell Library, Room 200
10 Shaw Road, Bridgewater, MA 02325
Tel: 508.531.1242

Contact the number above to ask general questions, to obtain information or offer input, and to express concerns or complaints about research. You may also call this number if you cannot reach the research team or if you wish to talk to someone else. General information about participation in research studies can also be found at https://my.bridgew.edu/departments/IRB/SitePages/Home.aspx.

Do not sign provide consent unless you have had a chance to ask questions and have received satisfactory answers to all of your questions.

At the start of the recorded interview, I will ask for your verbal consent. Before I ask for your verbal content, please be sure of the following:

· you have read this consent form (or it has been read to you) and have been given the opportunity to ask questions and have them answered;
· you have been informed of potential risks and they have been explained to your satisfaction;
· you understand that Bridgewater State University has no funds set aside for any injuries you might receive as a result of participating in this study;
· you are 18 years of age or older;
· you are aware that your participation in this research is completely voluntary;
· you are aware that you may leave the study at any time; if you decide to stop participating in the study, there will be no penalty to you and you may choose whether I retain or destroy your video footage and any data collected during the interview.

Before we begin the interview, I will ask for your verbal consent to participation in this study based on the information in this document.

Version Date: ***11/30/2020***