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What Methods and Models Can Be Used to Translate Science to Levels Developmentally Appropriate to Be Taught in Preschool in the State of Massachusetts?

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Developmentally Appropriate To Be Taught In Preschool In The State Of Massachusetts?

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A capstone project submitted in partial fulfillment of the requirements for the degree of Master of Arts in Education: Natural Science and Environmental Education

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ABSTRACT

This capstone project examines the changes in curriculum for early childhood education, specifically preschool aged children. In reviewing and learning about the history of preschool education and how its curriculum has evolved over time, this capstone project was developed to understand the question of, *what are methods and models that can be used to translate science to levels developmentally appropriate to be taught in preschool in the state of Massachusetts?* While preschool's curriculum main focus was in teaching fine and gross motor skills, research has shown that children as young as 3 years old are able to learn basic science, technology, engineering, and mathematics (STEM) principles (Copple & Bredekamp, 2009). Preschool students are able to understand STEM principles through inquiry. By using an inquiry based teaching model this allows students to have a hands-on learning experience while understanding basic science principles and learning to utilize critical thinking skills.

DEDICATION

To:

My mom and dad, for always supporting me through all of my different adventures.
Friends near and far, for always being there when being there was the most important.
Those who have impacted my careers journey from the smallest to the biggest of ways.
The next adventure that lies ahead.

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CHAPTER ONE

Introduction

Today, there is a lot that educators need to teach their students. If an educator teaches elementary-aged students, they need to make sure that students learn all the core content areas and that their lesson plans align to the specific state standards. This means teaching students reading, writing, mathematics, basic science, and much more. If an educator teaches either middle or high school students, they might be teaching a single subject, but their lesson plans would still have a very clear direction in order to align with the state standards. However, when it comes to what is taught to early learners, specifically students in preschool, teachers have not always had a clear direction on what to include in their lessons and to be taught.

When it comes to preschool, there has been a focus on both fine and gross motor skills but not necessarily a focus on academic content. In recent years though, there has been a major change in the teaching and structure when it comes to educating children in preschool. In the state of Massachusetts there has been a shift to teaching preschoolers standard-based curriculum. While this curriculum might not be as detailed as what is taught to students in elementary to high school, there is still a focus on a very basic curriculum in relation to standards-based learning. Due to this, for my capstone project I will be developing a standards-based curriculum taught to preschool-aged children and specifically looking at, *what methods and models can be used to translate science to levels developmentally appropriate to be taught in preschool in the state of Massachusetts?*

Personal Background

I can remember the first time I truly realized that I loved science. My love first started with the environment. While growing up, I was fortunate to be able to go on many camping trips and travel to several places that taught me about the ocean, mountains, and so on. One experience that always stands out to me is spending Sunday's at Beavertail State Park with my parents during the summer. This State Park is along the coast of Rhode Island where I grew up. During these trips, I remember going tidepooling and finding sea stars, crabs, periwinkles, and so much more. Most importantly, I remember the ocean and the sound of the waves crashing against the rocks during high tide. My parents saw this excitement and my passion for the environment. They enrolled me in ZooCamp at Roger Williams Park Zoo, where I spent my summers from the age of 11 all the way to the age of 20, when I worked as a camp counselor. It was during these summers that my love for education grew.

I had never thought of going into education but during those summers working with children at ZooCamp my passion for teaching started to grow.Later on, at the end of my AmeriCorps year (2009 to 2010), right after I graduated with my bachelor's degree, I realized how important education, especially informal education is. When speaking about education there are two different ways that you can approach teaching. The first way is the more traditional way, which is known as formal education. Formal education is a classroom teacher. It is an educator who works in a school classroom either for a public, private, charter, or Montessori school. Informal education is all other educators who don't fall into the other category. For example, informal educators are those teachers who work in the education departments for organizations such as museums, zoos, and aquariums. During my AmeriCorps year, I was an informal educator where I was in charge of a middle school afterschool program called "Pets & Vets", where students went on field trips to zoos, nature centers, veterinary offices, and other similar institutions. On one of these field trips, a young girl came up to me and said, "Donna, I think I know where we are." I responded with, "Oh, where do you think we are going?" The young girl then said, "Connecticut." To this day when I look back at that moment I remember feeling sad, but hopeful. I felt sad that this young girl only really knew the city she was growing up in. I felt sad that she, up to this point, didn't have the opportunities I did at her age to see more than just the area where she was living. In that moment I realized how important these experiences are, and how important informal education is for children.

The reason why this young girl thought that we were going to Connecticut is that she saw green. She saw trees and grass. The last time she saw this was when her aunt and uncle had taken her to Connecticut. During this field trip we were only a half hour, at most, from Providence. We were still in the state of Rhode Island, but she had never been exposed to the idea that Rhode Island had more in it than the concrete and buildings of Providence. On this field trip she was exposed to a bigger idea of what her state looked like. It was at that moment that I knew I wanted to be an informal educator for either zoos, aquariums, museums, or other STEM (science, technology, engineering, mathematics) organizations. I realized how important hands-on, real life experiences are to students and how much they learned from opportunities taking place outside the classroom. I wanted to be able to give a child that real life experience with the world and make a difference in their lives.

After my AmeriCorps year, I was fortunate enough to get a part-time position at Mystic Aquarium in their Education Department. I was again teaching informally to students from the grades of kindergarten through high school about the environment and conservation education. I greatly enjoyed working in this role where I got to be a camp counselor, an aquarium educator, and an outreach educator. While I really enjoyed Mystic Aquarium it wasn't until 2012 that I got a full time educator position at the Museum of Science, Boston.In this role that I was able to bring my love and passion for all of the sciences together. My role at the museum was a Traveling Programs Educator. I drove all over New England bringing science curriculum aligned to the state science standards (physics, chemistry, life sciences, engineering, etc.), to students during the school year in grades kindergarten through 8th grade, and during the summer months, I taught science curriculum for library and camp groups.

While I enjooyed teaching elementary to middle school students, it was at the museum that I really grew to love teaching early learners, particularly preschool students. Even though my primary responsibility was a Traveling Programs Educator, I was fortunate enough to help teach in the Museum's Discovery Center. Within the museum, this is an exhibit space that is targeted for children from birth to 8 years old, primarily focusing on early learners. This exhibit space allows younger guests to enjoy the museum in a different way than in other exhibits.

This is where I learned of some pedagogy for early learners, specifically that in the past there was more of a focus on fine and gross motor skills, but not an emphasis on curriculum-based content. However, in recent years, studies have shown that children as young as 3 years old (possibly younger) are able to understand curriculum (science content) depending on how the information is taught. The Museum of Science, Boston is one facility that participates in active research by using "research tools" in different science backgrounds to see what children understand and take away from what is being taught to them. Research tools are a way of collecting data and can come in many different ways. For example, common research tools that are used in helping to see a child's fine and gross motor skills is to use objects where the child would match colors, group objects together based on similarities (color, shape, size, patterns, etc.), and if age appropriate, using tools to see a child's knowledge of numbers. At the museum I utilized some research tools with preschool students to better understand what information the preschool students are able to understand. One of the best examples I have of using a research tool was using blocks that were different shapes and colors. The blocks were placed in a box where the students had to match the shape of the block to the box. The tricky thing about this was that on the box, around each one of the block shape outlines, it was highlighted in a different color than what the corresponding block was. While this is still observing fine and gross motor skills, these types of activities allowed me to better understand the critical thinking process that the young learners use and if the students understood the concept of shape, size, and color.

Project Context and Rationale

At the Museum in Traveling Programs, programs are offered to school groups in grades Kindergarten through 8th grade during the school year. In the summer months programs are offered to public audiences either at libraries or camp groups, but the age range for these programs are also targeted to children of Kindergarten through 8th grade, as well as adults. However, in the Museum as a whole, there is a big push for science programming for the preschool audience. This push for more science curriculum for preschool aged students comes from the overall shift that has been happening with preschool curriculum within the museum. While, in the past, there have always been guidelines for content that is taught to preschool aged children, there has been a gradual shift to standards-based learning for preschool-aged children throughout the museum that aligns more with state standards. The content areas that this preschool program will cover are physics and engineering principles.

With this shift, and the research that has been done, the Museum's education department decided to offer more programming for this age range. The Museum's education department consists of departments specializing in different types of programming for the museum. The departments that focus on school programming are:

- Live Presentations - Focus on programming and presentations taught at the museum for field trip groups visiting the museum.
- School & Youth Programs - Focus on programming and presentations for schools

in Boston that visit the museum. Educators from this department will also visit these schools.

- Traveling Programs - This is solely an outreach program. Educators in this department will drive to schools within Connecticut, Massachusetts, New Hampshire, Rhode Island, Maine, and Vermont and teach museum programming for schools for students in grades K-8th

As stated above in Traveling Programs, programming is offered to students in K-8th grade, but originally the department did not have any program offerings that fit state guidelines as well as the National Association for the Education of Young Children (NAEYC) for preschool programming. Due to the high demand of requests by preschool teachers for outreach options it was decided to develop and create the Museum's first outreach preschool program.

The hopes in the Traveling Programs department offering an outreach program from the Museum is to:

1. Gain better partnerships with both public and private preschool teachers, and with this partnership, offer professional development to these teachers through the Museum's teacher professional development program.
2. Be able, in the future, to develop more outreach preschool programs so that there is diversity in programming that is offered for this audience.
3. Broaden the reach of the Museum's programming to children and communities that allows them to experience science, technology, engineering, mathematics (STEM) education through observation and imagination.

With a desire to increase the Museum's reach to children and communities and to put a stronger focus on preschool education, this entailed a lot of work from the ground up. As discussed with the Traveling Programs education team at the Museum there will need to be a survey that is created to send out to preschool teachers in multiple communities around the Boston area and throughout Massachusetts. There will also need to be the development of the curriculum that will be taught, and program equipment that will also need to be built, which are pieces that will be a part of the Capstone. As part of this Capstone, other than the curriculum and equipment development, I want to research best practices for teaching science curriculum to preschool students from the ages of 2.9 years to 5 years old. While I will not be able to directly see the impact of the curriculum and the program components during the duration of my Capstone project, I hope that similar research and programming will help guide me in the development of all the program components including best practices for teaching, curriculum development, and appropriate program materials.

Summary

In this first chapter I highlighted my personal background for why the project for early learner education is of importance for myself and for the Museum of Science, Boston. The chapter focused on why the Museum finds preschool education essential to its mission. It also demonstrated how the organization can broaden its reach to this community with more Museum activities, but more importantly by developing and offering outreach programming.

The second chapter of my Capstone will be researching and reviewing early learner education, which will include: pedagogy, previous guidelines used in teaching, new standard based teaching, and best practices for teaching early learner (preschool) children. In researching and reviewing resources in early learner education this will help in answering my research question, *what methods and models can be used to translate science to levels developmentally appropriate to be taught in preschool in the state of Massachusetts?*

Chapter Two

Literature Review

In my teaching career I have primarily taught upper elementary and secondary education age students. It wasn't until the last five years that I have branched out into early childhood education. Early childhood, or preschool, education has become a huge passion of mine. Preschool education is interesting in that there are no national standards, but instead there are guidelines for preschools and daycare centers to follow. Recently, there has been a change in preschool teaching that is more curriculum based, which looks at subject areas like science and art. Now that preschool curriculum is being looked at on a more national level my research question is, *what methods and models can be used to translate science to levels developmentally appropriate to be taught in preschool in the state of Massachusetts?* While it is important to understand how to translate science to a level that is developmentally appropriate for preschool, there are also some other topics that would be helpful in this understanding. The other topics to look at include: issues in early childhood education, developmentally appropriate curriculum, STEM learning, and best teaching practices or methods.

As my research question states, *what methods and models can be used to translate* *science to levels developmentally appropriate to be taught in the state of Massachusetts,* this project will focus on creating a STEM curriculum for preschool. In order to do this the research question will need to be broken down into different components to understand the steps in creating a successful, developmentally appropriate curriculum. This literature review in the next section begins with issues that preschool curriculum and education has faced in the past to present day.

Issues in Early Childhood Education

For many years early childhood, unlike students in Kindergarten through 12th grade, focused on learning fine and gross motor skills. In 2003, the National Association for the Education of Young Children (NAEYC) developed and finalized standards for preschool students which include fine and gross motor skills, social and emotional skills, and also incorporate other curriculum like the arts, writing, and science. However, one of the biggest issues in early childhood education is that in its initial development, early childhood programming was funded and oversaw by government action for many years. Preschool programs for many years have gone through government action and inaction. This means that there are many preschool programs that are now linked to different standards, rules, and regulations (Feeney et al., 2009). Feeney et al. (2009) go on to discuss how this has led to a lot of confusion for when:

1) Parents have trouble accessing and understanding differences among program offerings.
2) Policy makers are not sure of the comparative quality and outcomes of the programs and of the comparative value of their investments.

It is important to remember that at one point in time it was important to have multiple types of preschool programs that would fit the needs of families. As Feeney et al. (2009) state, “Multiple programs provide a bevy of options for which parents can choose to enroll their children at different ages and different times of the year” (pg. 14). Due to what Feeney et al. (2009) describe, this way of thinking led early childhood education into regularized and organized funding but there was a lack of resources. As time has gone on, family needs have shifted and educational goals have shifted as well. Early childhood education, instead of falling under government action, has now become how a multitude of public and private initiatives can be configured to maximize efficiency, outcomes, equity, excellence, and individuality (Feeney et al., 2009).

When taking a closer look at the shift in family necessities, one of the biggest needs for enrolling a child in a preschool program is due to both parents working. For example, from an article written by the National Institute for Early Education Research (NIEER) they state that, “nationwide, state-funded preschool program enrollment exceeded 1.5 million children” (2020). With the increase in numbers of children enrolling in preschool another way to look at this data is the change in the modern family unit. In an article written by Concordia University in Saint Paul, Minnesota (2020) it is discussed how during the 50’s it was the norm to have middle-class, child centered families that were headed by wage earning husbands. If we are to jump from the family unit of the 50’s and early 60’s to modern times Concordia University writes, “many of the changes are a direct result of an expanding role of women in society, both in terms of the workplace and education” (2020). With women becoming more prevalent in the workplace and receiving higher education this meant that there was no longer one adult designated to be home with the children. Another article that agrees with what Feeney et al., described as a shift of early childhood education from government to governance is an article by Atchinson and Diffey (2008). In this article titled, *Education Trends: Governance in Early Childhood Education,* Atchinson and Diffey (2008) write that there is a disconnect in early childhood education and that this disconnect is clearly seen between the birth to age five system and grades Kindergarten to 3rd grade. Atchinson and Diffey go on to say that, "state education governance-the practice of coordinating institutions, processes and norms to guide collective decision-making and action-is crucial" (2008, pg. 2). The whole purpose of governance is to address the alignment issues to grade level curriculum by providing structure in the form of authority, accountability and a coherent strategy for achieving a birth-to-age-five strategy that aligns with K-3 (Atchison and Diffey, 2008).

With early childhood education evolving, the term "governance" is more commonly used. Feeney et al. (2009) defines governance as "the means by which actors use purposeful efforts to guide, steer, control, or manage sectors or facets of society" (pg. 15). We can think of governance as a way or process where a collective group can come together to make important decisions. These decisions are usually regarding delegating? resources and who will be involved in the decision-making process. So, how does the switch to governance affect early childhood education? As Feeney et al. (2009) states, "governance works to ensure that all programs are expected and supported in their efforts to attain quality standards for themselves and for their teachers, to be affordable, and meet the needs and meaningful experiences that prepare them to be successful lifetime learners" (pg. 15).

It was in the 1960s that governance was started. When implementing governance it was introduced in different phases. Feeney et al. (2009) lists these phases as: Phase I: The Programmatic Approach, Phase II: Coordination and Collaboration, and Phase III: Moving Toward Shared Responsibility and Accountability. Once the different phases were implemented, it was then a matter of how each state would implement these changes. Atchison and Diffey state that, "currently, at least 5 states have what they define as a department of early learning, and every state but one has an early childhood advisory council" (2008, pg. 3). Additionally every state also has an education agency that houses an early childhood administrator, who likely oversees early learning programs — including school readiness, pre-K, special education and others. States also have a child care administrator, most often housed in the department of human services who oversees the federal Child Care and Development Block Grants. These grants are to support child care for low-income families, for child care licensing, quality improvements and often programs such as resource and referral or family support. While the benefits of having governance in early childhood education is primarily to help oversee the administration of these programs, Atchison and Diffey also go on to explain that the benefits of early learning governance also include:

- Establishing vision setting entities that can align state goals
- Increase efficiency
- Increase public/private partnerships, federal-state-local coordination and the

alignment of early childhood services across government entities

- Initiates supports and infrastructure that improve outcomes for young children
- Reduces duplication of efforts
- Increases responsiveness
- Maximizes fiscal and human capital resources

Developmentally Appropriate Curriculum

This section will discuss what makes a successful preschool program when it comes to developing curriculum. In early childhood it is stated that "optimal development and learning during the preschool years is most likely to occur when children establish positive and caring relationships with adults and other children" (Copple and Bredekamp, 2009). Copple and Bredekamp (2009) go on to explain there are guidelines for developmentally appropriate practice. Before looking at the guidelines defined by Copple and Bredekamp, we also need to understand what is meant by developmentally appropriate practice. Developmentally Appropriate Practice, or DAP, is defined as "an approach to teaching grounded in the research on how young children develop and learn and what is known about effective early education" (NAEYC, 2009, p. 10) the developmentally appropriate guidelines are listed as:

1) Creating a caring community of learners
2) Teaching to enhance development and learning
3) Planning curriculum to achieve important goals
4) Assessing children's development and learning
5) Establishing reciprocal relationships with families

When planning a curriculum for early learners it is important that it consists of the knowledge, skills, abilities, and understanding children are to acquire and the plans for the learning experiences (Copple & Bredekamp, 2009). When thinking about how to create a developmentally appropriate curriculum it can be broken down into categories. According to the National Association for the Education of Young Children (NAEYC), these categories include:

- Physical Development
- Social Emotional Development
- Cognitive Development
- Language and Literacy Development

All of the above categories, as described by NAEYC, is categorized as Developmentally Appropriate Practice (DAP). DAP is a framework that has been designed to help promote young children's optimal learning and development.

Preschool and Science, Technology, Engineering, and Math (STEM)

While preschool curriculum and standards are still a very new idea a lot of people have voiced, "why STEM?" One of the biggest reasons for STEM is that, "student achievement in STEM is low" (Counsell et al., 2016). When developing STEM curriculum Counsell et al. (2016) talks about using a Ramps and Pathways (R & P) approach to help engage young children in inquiry and problem solving. This type of approach to curriculum development is an approach to designing experiences that engage young children in creating and building structures to help with science inquiry. When speaking about experiences, these experiences are meant to be hands-on learning, as well as social and emotional learning. According to an article written by NAEYC (2020) it says that for preschool development there needs to be multiple factors that come together. These factors are: Physical, social, emotional, and language and literacy development as well as thinking, or cognitive skills. Each one of these factors are important to create valuable learning and experiences for preschool students. If we were to look at each one of these developmental categories, while maybe not directly related to STEM, each one of these developmental categories are found in a successful preschool program.

Physical Development

Physical Development is defined as, "the way a child moves his or her arms and legs (large motor skills) and their finger and hands (small motor skills)" (NAEYC, 2020). During this developmental stage, teachers are helping students learn these skills by offering different types of activities and equipment for the students to learn. NAEYC (2020) lists some of the equipment as:

- Children running, jumping, climbing, throwing, and catching
- Having children use their hands to explore materials like paint, playdough, puzzles, sand, and writing utensils

Social and Emotional Development

Social development is defined as, "helping children to get along" (NAEYC, 2020). Emotional development is defined as, "letting the child understand their feelings and the feelings of others" (NAEYC, 2020). Both of these types of development are usually learned at the same time by preschool students. In the preschool class both social and emotional development are taught through play. Play can have many meanings, but in the preschool classroom space play is shown by having students use costumes (imaginative play), or can be shown by having students make slime, draw a picture, and practice writing on a board. NAEYC (2020) goes on to explain social and emotional development as having students playing and learning with one another which will help in the learning of social skills, language skills, and self control. Teaching social and emotional development if crucial in helping students build self-esteem.

Language & Literacy Development (Thinking, or Cognitive, Development)

Language and literacy development and thinking, or cognitive development are two different types of developmental learning that are very similar. NAEYC (2020) defines language and literacy development as, "helping the student understand and communicate through listening, talking, reading, and writing." Looking at the NAEYC definition of thinking, or cognitive development they define this as, "learning to think more complexly, make decisions, and solve problems." Teaching STEM is a prime example of introducing both of these developmental learning styles. Young children love to explore. It is through this exploration that they learn to question, create, and then improve their critical thinking skills (NAEYC, 2020).

Overall, all of the above developmental learning is connected and can be taught in many different ways. Going back to Counsell et al.(2009) and the Ramps and Pathways programming, this programming utilizes all of the learning development that is discussed above. When writing about the Ramps and Pathways, Counsell et al. explains this approach as a curriculum designed to "actively engage children in engineering design and scientific inquiry" (pg. 10).

Bringing STEM into early childhood, specifically preschool, is something that isn't entirely new. For example, there is extensive research that was done by scientist Jean Piaget that looked into how children come to know what they know. In Jean Piaget's research, he looked at developmental psychology and how this relates to a person's cognitive development. Cognitive development is looking at how children think, explore, and figure out problems that might be presented to them. Piaget, when studying cognitive development, put these stages into 4 different stages. These stages listed by, Educational Psychology Interactive (2003) list Piaget's stages as:

1) Sensorimotor Stage (Infancy)
2) Pre-operational Stage (Toddler and Early Childhood)
3) Concrete Operational Stage (Elementary and early adolescence)
4) Formal Operational Stage (Adolescence and adulthood)

Counsell et al., agrees with this research by writing, "that children construct knowledge of the physical world through exploring, experimenting, and forming early beliefs (or theories) about how the world works" (pg. 12, 2016). Overall, the research shows that even if young children's theories may be incorrect from a scientific perspective, it is these theories and ideas that represent their best efforts to make sense of their surroundings. With the above information, how was STEM implemented into early childhood education? According to Counsell et al. (2016), it is explained that underestimation of teaching STEM to younger children needed to be overcome. For example, if we were thinking about teaching physics to preschool children there are three categories of physics knowledge that would need to be understood. The three categories of physics knowledge, as according to Counsell et at., include:

1) Factual Knowledge
2) Conceptual Knowledge
3) Procedural Knowledge

While STEM is much more than just physics, engineering and physics are some of the easier subjects to first be taught to preschool students. To understand Counsell et al. (2016), defines what factual, conceptual, and procedural knowledge means for preschool students. Factual knowledge is defined as, "knowledge of specific events and situations" (pg. 13). This factual knowledge is knowledge that can be obtained directly through experience. What this means is that a preschool student will be able to understand that when a ball is released from the top of an incline that the ball will roll down the incline. Counsell et al. further explains factual knowledge as, "some knowledge that is accepted on the basis of authority, rather than experience" (pg. 13). However there is a slight flaw with accepting factual knowledge. The biggest flaw is that accepting knowledge based solely on authority causes the learner to not completely understand or believe the knowledge due to the "seeing is believing." Another way of defining factual knowledge is to think about this as a way for preschool students to learn through self discovery. In the journal K12: Learning Liftoff (2020) there is an article which gives suggestions on how a preschool student might learn through self discovery, or factual learning. The article states that a preschool student can learn STEM through self discovery by:

- Teachers treating all students as STEM learners and ensuring that all students have equal opportunities

- Teachers actively listening to children and watching how the students play and relate to one another
- Teachers encourage students to discuss and elaborate on both their ideas and findings
- Teachers suggest further investigations to test their ideas.

In this same article by K12 it is also explained that students should be introduced to these STEM subjects before Kindergarten. During this time, teachers should allow students to engage in quality STEM learning from preschool through at least 3rd grade. With thinking about what Counsell et al. discussed about factual learning, K12 agrees that teaching STEM in the early years enables children to make connections between everyday life and the STEM disciplines that will be taught later in schooling. While factual knowledge is important, there are also two other knowledge checks that are equally as important for students to understand. These are conceptual and procedural knowledge.

Conceptual knowledge can be defined as, “knowledge of physical principles that bring many pieces of factual knowledge together into a unified whole” (Counsell et al., 2016, pg. 13). The idea behind this is that children, even at an early age, are able to bring different pieces of knowledge together into a unified whole concept of thought. A great example of how conceptual knowledge is shown in preschool students can be seen through a very common preschool activity. This preschool activity is when students place different objects into a tub of water and observe if those objects are going to sink or if they are going to float. By doing this activity preschool students are able to develop their own explanations. For example, that all heavy objects are going to sink and all light objects are going to float. This explanation is incorrect, but what this shows is "an example of a child's attempt to pull together pieces of factual knowledge and unify them into a concept that can be used to explain and predict events" (Counsell et al., 2016, pg. 13). The last step in understanding bringing STEM into preschool is procedural knowledge. Counsell et al. (2016) describes procedural knowledge as "knowledge of how to apply factual and/or conceptual knowledge to specific problem solving solutions" (pg. 14). Another way of thinking about procedural knowledge is that it is knowing how to use what you know to solve or figure something out.

If we are to look at all three, Factual, Conceptual and Procedural Knowledge, these ideas have been brought into preschool classrooms with teaching STEM. Counsell et al. (2016) explains this by concluding that "ongoing experiences in STEM enable children to organize their factual knowledge into systems that serve as the early foundation for the later development of conceptual knowledge" (pg. 14). Overall with bringing factual, conceptual, and procedural knowledge into the preschool classroom through STEM helps with aligning to the Next Generation Science Standards which students in Kindergarten through high school follow.

Best Teaching Methods

For Kindergarten through 12th grade classrooms, there are a lot of resources for best teaching methods. Best teaching methods, or pedagogy, tend to go along with curriculum. While preschool curriculum is up and coming there has been current documentation from the National Association for the Education of Young Children (NAEYC) on teaching pedagogy for early learners. This criteria written by NAEYC Accreditation can be broken down by:

1) Standards for each early learner level

2) Rationale behind each accreditation criteria

Some issues do arise when introducing STEM into the preschool classroom. For example, students who are in grades Kindergarten through high school follow a set of science standards known as the Next Generation Science Standards (NGSS). As stated on the website for NGSS (2013) it explains how the standards are split into three equally important dimensions for learning science. The three dimensions are not entirely separate. The standards are set-up so that each dimension works with the other two dimensions to help students build an understanding of STEM concepts over time. The three dimensions dimensions are listed as:

1) Crosscutting Concepts
2) Science and Engineering Practices
3) Disciplinary Core Ideas

Below is a figure that highlights one area of NGSS. The figure looks more closely at engineering and how the three categories for NGSS intersect to help students learn the knowledge over a period of time instead of all at once.

Figure 1. NGSS Framework for Engineering Design

Students who demonstrate understanding can:

K-2-ETS1-1. **Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.**

K-2-ETS1-2. **Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.**

K-2-ETS1-3. **Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions.

- Ask questions based on observations to find more information about the natural and/or designed world(s). (K-2-ETS1-1)
- Define a simple problem that can be solved through the development of a new or improved object or tool. (K-2-ETS1-1)

Developing and Using Models
Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.

- Develop a simple model based on evidence to represent a proposed object or tool. (K-2-ETS1-2)

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Analyze data from tests of an object or tool to determine if it works as intended. (K-2-ETS1-3)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1)
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)
- Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)

ETS1.B: Developing Possible Solutions

- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)

ETS1.C: Optimizing the Design Solution

- Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)

Crosscutting Concepts

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Connections to K-2-ETS1.A: Defining and Delimiting Engineering Problems include:
Kindergarten: K-PS2-2, K-ESS3-2
Connections to K-2-ETS1.B: Developing Possible Solutions to Problems include:
Kindergarten: K-ESS3-3, **First Grade:** 1-PS4-4, **Second Grade:** 2-LS2-2
Connections to K-2-ETS1.C: Optimizing the Design Solution include:

K-2-ETS1 Engineering Design, Next Generation Science Standards, 2013.

When thinking about the above standards for older students, these concepts have been brought into early childhood education through a different model known as, the Inquiry Teaching Model. Counsell et al. (2016) explains that ideas should be taught as a process of inquiry, rather than knowledge that is continuously changing. This is a similar idea that the above NGSS figure has for older students with building upon knowledge instead of knowledge continuously changing. Counsell et al. (2016) goes on to explain that "students at an early age can begin to focus on the processes of doing investigations, develop the ability to ask scientific questions, and investigate aspects of the world around them, all of which can eventually lead them to use their observations to construct reasonable explanations for questions posed at a later age" (pg. 15). From this idea that inquiry plays a very important role in teaching STEM to preschool students, the below inquiry model was developed to help teachers develop, plan, implement, and evaluate STEM instructional experiences for early childhood education. Counsell et al. (2016) states that the below inquiry teaching model "is grounded in both early childhood and science education learning theories" (pg. 15).

Figure 2. Inquiry Teaching Model

Engage Learners	**Make Informed Decisions**	**Provide Opportunities**
Identify interests and prior ideas, skills, and experiences.	Check for understanding	Facilitate exploration
Activate a learner's prior knowledge experiences	Intervene to promote deeper thinking	Support problem solving
Stimulate Interest	Integrate other curricular areas	Scaffold experimentation
Capitalize on the learner's natural curiosity	Document learning	Provide faster communication

Next Generation Science Standards, 2016.

If we are to look at the inquiry teaching model and to think about best teaching practices for early childhood education, specifically preschool, we can split the model into three categories. These categories are:

- Engage the Learners
- Make Informed Decisions
- Provide Opportunities

Each of these categories come with a more in depth explanation as to why they are the focus for STEM in early childhood education. Below, is a closer look at each of the categories and how they relate to early childhood education and relate back to the ideas of factual, conceptual, and procedural knowledge. First I will describe Engage the Learners and what this means for teaching STEM in early childhood classrooms.

Engage Learners

Engage Learners is a key component for best teaching methods in STEM education for preschool students. It has been shown that engaged learners tend to invest more mental energy into learning than unengaged learners (Counsell et al., 2016). Counsell et al. explains engaging students involves identifying and stimulating children's interests, activating their prior knowledge and experiences, and capitalizing on their natural curiosity (2016). When teaching, and wanting to make sure that students are engaged, it is important to remember that young children are naturally curious. As

Counsell et al. (2016) states , “young children’s curiosity is limited only by the experiences they are allowed” (pg. 17). Counsell et al. make great points about why engaging learners at such a young age is a key component for best teaching methods in STEM education. For example, in a study conducted by Stanford University (2019) it focused on engaging preschool students in STEM. In this study conducted by Alissa A Lange. PhD and the National Science Foundation (NSF) focus on why STEM and engaging young learners is so important. From this study it was found that:

- Young children enjoy problem solving problems and exploring the world through STEM
- There are fun and easy ways to engage and introduce STEM to preschoolers
- Engaging students in STEM learning can support children’s development and many other important skills

Like Counsell et al. states, “engaging students involves identifying and stimulating children's interests, activating their prior knowledge and experiences, and capitalizing on their natural curiosity” (2016). In this study Alisa A. Lange. PhD and the NSF concluded that “when engaged in activities that support STEM learning, young children can remain curious, focused, communicative, and active” (2019).

Provide Opportunities

Providing opportunities in a preschool classroom is done through play. Counsell et al. (2016) state that very early, babies begin life by exploring the world in order to figure out how it works (pg. 18). This is usually shown through play. Counsell et al. further explain that, “During play, children learn about the properties of materials and objects, identify variables, notice patterns, and begin to construct cause-and-effect relationships” (pg. 18, 2016). This basic exploring provides children with a common base of experiences. It is these experiences that teachers are able to draw from to help in designing more in-depth to specifically highlight particular concepts, skills, and processes that teachers will want to introduce to students when teaching STEM (Counsell et al. 2016, pg. 18). The best practice of providing opportunities in the classroom is to also understand what is needed in the classroom space. Counsell et al. (2016) breaks down how teachers should set-up their classrooms and how teachers should facilitate learning to help in providing the students with new learning opportunities. Counsell et al. (2016) explains these components as:

- Making adequate space and materials available to children
- Giving children enough time to explore
- Creating a safe environment in which exploration is valued and nurtured
- Observing children to make sure that they know how to play and explore

With this, the role of the teacher is primarily a facilitator in which the teacher is setting up the classroom environment, observing children, and providing assistance when needed. However, when providing children with opportunities, Counsell et al. (2016) explains that there are key things that a teacher needs to remember to make sure that learning isn’t difficult. Counsell et al. (2016) states that, “If too many variables are presented to children, they have difficulty noticing patterns in which the materials react” (pg. 19). It is important to remember while providing opportunities for learning that the teacher doesn’t complicate the learning process with the use of too many materials at once.

While Counsell et al. focuses on providing opportunities in the preschool classroom through play, another important factor in providing meaningful opportunities is through classroom design. In an article written by Judith Colbert it states, “when a space is well-organized, with open pathways that clearly lead to activities that offer enough to do, children manage on their own. They can move freely from one activity to another, giving opportunity” (2008). The idea behind having a classroom that is neat and well-organized is to make it so that the students have easy access to the materials in the classroom. These materials might be for imaginary play, reading, writing, or table top activities. By having a classroom where these materials and activities are easily accessible this allows the students, especially during free play, to choose what they would like to do.

Make Informed Decisions

Making informed decisions is usually done by teachers making observations of the classroom and students so that the teacher will know what to do next (Counsell et al. 2016). The following list from Counsell et at. (2016) is an example of what teachers might do in helping making informed decisions:

- Questions to check for understanding
- Drawing children’s attention to something they had not noticed

- Making comments that prompt children to think about something in a new way
- Posing problems for them to solve
- Asking children to explain what they are working on, or what they have done

For teachers, making informed decisions also means understanding that at this stage in a students development, students can't compartmentalize things into categories like "science," "technology," "engineering," and "math." This is a developmental trait that happens later. This means that teachers will need to "make decisions about how to integrate the curriculum across multiple content domains" (Counsell et al. 2016, pg. 19). STEM curriculum is a great example of this because it offers opportunities for students to count, sort, measure, classify, write, talk and explain.

Summary

Throughout this chapter the issues in early childhood education were discussed, as well as how early childhood curriculum has evolved over time, how STEM is introduced into the preschool classroom, and what the best teaching methods are in teaching STEM to preschool students of the ages 2.9 to 5 years old. While it is still important for preschool students to learn fine and gross motor skills during this developmental time, this chapter discussed how research has shown that students as young as 3 years old are able to learn STEM content by using an inquiry based teaching model.

Chapter 3 discusses the methods used to create a STEM preschool curriculum for a museum that will allow increased opportunities for the museum to bring their programming to a new audience.

Chapter Three

Project Description

This chapter will include a more in-depth explanation of how this project will be answering the question, *what methods and models can be used to translate science to levels developmentally appropriate to be taught in preschool in the state of Massachusetts?* Within this chapter is a detailed explanation of the overall project, the goals of the project, the targeted audience, curriculum framework, the educational setting where the program will be taught, and how the program will be taught and also evaluated for best practices.

This capstone project is the creation of the Museum of Science, Boston's first preschool outreach program, with the development of two additional preschool programs. The development of the different program components will need to contain research of program supplies that are suitable for preschool students, and building of program equipment. The program itself will be no longer than 45 minutes in length, but can be shorter if necessary (no shorter than 30 minutes). The program will be taught to preschool-aged children (2.9 years to 5 years old) offsite from the Museum itself. This will primarily be an outreach program targeted specifically to preschools, but can be taught either at camps or libraries as long as the appropriate age range is in attendance.

The curriculum for the program will be written so that it uses the best practices and methods that were researched and reviewed in the literature review (Chapter Two). The best practices and methods that were written into the curriculum are those suggested by NAEYC such as the Inquiry Teaching Model where teachers will be able to engage learners, make informed decisions, and provide opportunities for further learning. For the curriculum framework, the project will include a combination of frameworks that the Museum uses through their Engineering is Elementary (EiE) Department, Next Generation Science Standards (NGSS), and National Association for the Education of Young Children (NAEYC). The curriculum will be taught by Museum educators, and there will be an outline that educators will use to help guide them in presenting the program. There will also be a story that will be written by the Traveling Programs team and used during the program.

The purpose of creating an outreach preschool program is to broaden the Museum's reach to children and communities, but to also offer STEM programming to preschool children. While there is a solid foundation of STEM programming for children in elementary through high school, there isn't a lot of STEM programming (in an outreach setting) that is offered to preschool-aged children. Now that there is a shift in curriculum and methods used to teach preschool aged children in the state of Massachusetts, as well as nationwide, it is of importance for organizations like the Museum of Science, Boston to offer programming and expertise to this audience.

Setting

The Museum of Science, Boston is a non-profit museum located in Boston, Massachusetts that offers STEM (Science, Technology, Engineering, and Mathematics) exhibits and educational programming to the community. As the museum is located in Massachusetts, this means that the community includes all of New England (Massachusetts, Connecticut, Rhode Island, New Hampshire, Vermont, and Maine). With the Museum's community being across multiple states this means that there are multiple ways to experience STEM education that the Museum has to offer. Because the Museum's community includes all of New England this means that the museum offers outreach programming, engineering curriculum kits for teachers to purchase, on-site field trip programming, overnight programming, and virtual programming.

To deliver the Museum's educational programming, the programming needs to be designed so that the Museum's educational mission is delivered. The Museum's educational mission is to:

- Promote active citizenship informed by the world of science and technology
- Inspire lifelong appreciation of the importance and impact of science and engineering
- Encourage young people of all backgrounds to explore and develop their interests in understanding the natural world and human-made world

The Museum's education department is split into multiple sectors, each having a different role in delivering STEM programming and reaching the Museum's mission. The sector of the education department where this program will be developed, and the team of educators that will be teaching this program is the Traveling Programs department.

Traveling Programs at the Museum of Science, Boston is the outreach sector of the Education Department. Currently the Traveling Programs department comprises a full-time staff of 11 employees, including both the manager and coordinator. With this large of a team, there are six vans that the educators use specifically for Traveling Programs and the deliverance of the Museum's outreach educational programming. This means that during the course of the school year the educators will visit hundreds of schools and see thousands of students across the New England region, and a variety of types of curriculum can be taught. For example, a teacher could book a small audience program. Small audience programs are aimed at up to 60 kids per session, and there can be up to four 50-minute program sessions in a day. The type of programming that is offered through Traveling Programs is as follows:

- Small Audience - up to 60 students during one program session that is 50 minutes
- Large Audience - 150 students up to 300 students during one program session that is 60 minutes
- Workshop - One class of students at a time (25 to 30 students max). Program is 50 to 60 minutes

The programming can take place in any space that is suitable for its specific type. This means that a program could be taught in a library, classroom, auditorium, etc., depending on where the students and program equipment would fit best.

Length and Frequency

The curriculum that will be written for the preschool audience will be 40 minutes in length maximum. Due to how often programs are booked for students in grades K-8 during the school year, this new preschool program will first be offered during the summer programming months (June through end of August). During the summer programming months, just like school programming, programs can take place Monday through Friday and be booked during Traveling Programs hours of operation. Due to the program’s newness to the summer programming catalog, and having other extensive long-lasting programming, this preschool program will be available to two preschools per week. Due to the popularity of Traveling Programs’ other long-lasting programs, only 3 educators will be trained to teach this preschool program as this is a newer program and won’t be offered for booking as many days to the other long-lasting programs.

Intended Audience

In Traveling Programs, historically, the most common audience for school programming is grades 3-5, with grades 6-8 following closely behind. The same statistics are true for school field trips of students visiting the Museum itself. However, the Museum has seen a large rise in visitors that come with children of preschool age, and Traveling Programs has received more inquiries from preschool organizations interested about booking a presentation. Due to the rise in preschool Museum attendance, inquiries for outreach education for this audience, and more emphasis put on best practices of preschool education preschool students are the optimal audience for the development of a new outreach program. The preschool students’ age range is from about 2.9 years to 5 years old.

Curriculum Framework

At the Museum of Science, Boston the curriculum framework most of the programming adheres to is the Next Generation Science Standards (NGSS). However, NGSS starts at Kindergarten and then goes through high school. NGSS will still be very important when developing the curriculum for the preschool program as the Kindergarten standards will be reviewed and incorporated to some extent into the program especially for the students in the upper end of the preschool age range. The framework that will be most utilized in the writing of the curriculum will be from the Museum's Engineering is Elementary (EiE) Department and the National Association for the Education of Young Children (NAEYC). As the current programming for Traveling Programs at the Museum doesn't utilize these particular frameworks, we will rely heavily on the format that is used for other programming but with necessary adjustments.

Currently, most of the programming offered through the Traveling Programs Department has lesson plans and guidelines (not scripts) that educators can use to help in formulating their own programs. The preschool program's outline will include its title, length, a description of the objective(s), state standards and guidelines that the program aligns to, and a description for each section of the program that will highlight the main topic(s) of focus. Some of the topic(s) that the program will highlight are the following:

- Engineering Design Process - Specifically utilizing the engineering design process that is designed by the EiE (Engineering is Elementary) team at the Museum. The steps of the design process that the preschoolers will focus on are: Guess, Build, Try (Test).

- Testing Materials - In the first half of the program the students will focus on using and testing materials. This is very important in that the students need to understand the materials that they are able to use for the second part of the program, which is solving a problem by using the engineering design process.
- Light and Shadows - The whole program is about light, and depending on how the light is cast over a certain object, a shadow will be formed. This will be important to start with in the beginning of the program, as the science behind it will be taught throughout.

Summary

To answer the question, *what methods and models can be used to translate science to levels developmentally appropriate to be taught in the state of Massachusetts?* a new preschool outreach program was created. This new preschool program allows the Museum to broaden its educational mission to a wider audience, consisting of preschool (ages 2.9 to 5 years) to adults. This new outreach program focuses on preschool students, and allows the Museum to focus on teaching STEM content to a younger age range. Providing STEM education to preschool allowed the Museum's Traveling Programs Department to better understand this age range while working closely with other departments that are also focusing on early learner (preschool) curriculum. This preschool program can help organizations with preschoolers learn STEM in a way that is hands-on and still helps with the growth of students' fine and gross motor skills. The overall outline of the program will be based largely off of existing programming that is offered through the Museum's outreach department, but was modified due to the Museum's engineering design practices and program length. Educators will be given an outline, background information on the science content, and PowerPoint to see how the program is set-up and timing for each of the program content areas.

Chapter four discusses the major lessons that were learned during the creation process of this program and the conclusion of the capstone project as a whole. Chapter four will also include any changes or modifications that needed to be made during the program development process. The changes could include the length of the program, any outline changes, and anything else that was mentioned above in chapter three. Also, chapter four will reflect whether or not the program was successful, and if creating another preschool outreach program could be beneficial for the Museum's mission and business model. Finally, chapter four will reflect on what creating this preschool outreach program meant to me.

Chapter Four

Project Reflection

When I first started this capstone project I had no idea the journey that I was about to embark on. This journey has been challenging but also incredibly fulfilling. To see how far my project has come from the very beginning is a rewarding experience. When I first started to think about my capstone project I knew that I wanted to design a Science, Technology, Engineering, Mathematics (STEM) program for preschool students that would be taught by the organization I worked for, the Boston Museum of Science in Massachusetts. At the Museum my focus was on bringing the Museum's programming into schools throughout the New England area. Before this project the Museum's outreach programming was only for students in grades Kindergarten through 8th grade, but through previous work experiences I always enjoyed working with early learners. From those previous experiences I knew I wanted to design this program to show my love for science and early childhood education.

Thinking further about my project and how I wanted to incorporate my love of STEM and early childhood education I posed the question, *what methods and models can be used to translate science to levels developmentally appropriate to be taught to preschool in the state of Massachusetts?* In Chapter One of this paper I spoke about my personal background with STEM education, my passion for early childhood education, and my overall background that led me to this research question. Chapter Two explored issues in early childhood education, developmentally appropriate curriculum, how STEM fits into preschool curriculum, and the best teaching methods for STEM and early childhood education. Chapter Three looked more closely at the preschool program that was created for the Museum and its Traveling Programs Department. In order to understand the development of the preschool program Chapter Three looked more closely at the logistics of the program such as audience, length of the program, and curriculum design.

This chapter is a reflection of the program development process from researching the history of early childhood education to designing the Museum's first STEM preschool program. The first section of this chapter will explore the outcomes I have learned during the development process and any project changes that took place. The second section explores the limitations of the project that arose during the development process. The last section of the chapter looks at ideas for future projects that could be developed based off of this initial program.

Learning Outcomes and Project Changes

In my professional career I have had the opportunity to work in STEM education through organizations like the Boston Museum of Science. In my time at the Museum I have been lucky enough to learn from experienced educators in different STEM content areas including those areas of physics, chemistry, and earth and space science to just name a few. Through these observations I was able to learn how to teach STEM curriculum to varying audiences of different ages and audience sizes. I have been awarded many opportunities to attend different conferences on early childhood education for museums, as well as conferences that are specific to STEM teaching practices. It was through these opportunities that I was able to further my knowledge of early childhood education that I realized how important STEM is for early learners.

When bringing this knowledge and experiences to the process of developing and creating this preschool program, I learned a lot about early childhood education, curriculum development, and what the best teaching methods are for this age range. As someone who normally teaches students in grades Kindergarten through 8th grade it was a huge learning curve for what is a developmentally appropriate curriculum for preschool students. In my previous experiences I designed programming by to state science standards. In the state of Massachusetts the standards used for programming were the Next Generation Science Standards (NGSS). However, early childhood education doesn't have state standards. Instead, early childhood curriculum follows national guidelines. These guidelines go into great detail about gross, fine, and sensorimotor skills. These guidelines and learning about what was developmentally appropriate was something that was completely new to me and to the Traveling Program Department. Through the program development process it required a lot of research in understanding the details of the guidelines and how these guidelines could be translated into a STEM program for preschool students. Another important thing that I learned is how detailed the program development needs to be. At the beginning of the program I went into the project thinking that it would be as simple as picking a program topic and from there starting to build and design the program. Very early on I realized this is not the case at all.

Once it was decided that the next program Traveling Programs creates would be a preschool program it became very clear that there was a lot that needed to be done. Previously, most programs that were created for older students could be started and completed within a year. Overall, the preschool program from start to its completion and being taught to students took a total of two and a half years. One of the biggest lessons I learned through this process is that when developing a program for a new audience takes time and patience, and that in order to design a successful program the Traveling Programs Department needed to understand the audience who would be booking the program. Before this process I never really thought about developing a program so that it would appeal to teachers. I had always thought about program development as developing a program so that it appeals to the students. However, because this is a program for an informal science institution this means it wasn't as simple as creating a curriculum. It meant that I had to take into consideration program cost, how many students can attend the program at once, if the program would fit into the school's space available for the program, and other program logistics that come with outreach education. Due to needing to understand the teacher audience and overall logistics of the program this meant that a teacher survey needed to be developed so that the Museum could understand these extra details.

With these extra details meant that some things about the preschool development needed to change. One of the biggest changes to the program was the initial timeline. Originally, the timeline for the program development and completion was to take only one year to a year and a half. In the end, program development and completion took a total of two and a half years. While this wasn't ideal it did make for a much better program. With the extra time the Museum was able to gain knowledge and understanding from preschool teachers, as well as, collaborate with other departments to better understand what developmentally appropriate curriculum looks like. Allowing the extra time and not rushing meant that I personally was able to research developmentally appropriate practices in science curriculum and better understand the fine, gross, and sensorimotor skills that are required in early childhood curriculum.

In the end there were multiple changes that needed to be made other than extending the timeline for program development. The most notable changes was that the program materials needed to be changed multiple times during program development. The materials that were changed were for the engineering design activities where the students build a structure to solve a problem that the main character in the story encounters. Again, due to this being a new audience of programming for Traveling Programs this meant that understanding what program materials would work best for the students to manipulate was important. Throughout the whole development process the program materials changed a total of four different times. As well as the program materials changing some of the curriculum also changed. The part of the curriculum that changed the most was the story that was written for the program. The reason for the multiple changes in the storyline was so we could hopefully have a story that kept the students attention and also explained the design challenge that was developmentally appropriate. In total there were four different iterations of the story before the final story was decided upon.

Overall, the program development process was incredibly rewarding. Through the whole program development process I gained a much better understanding of early childhood education and what makes a successful curriculum. I was able to design a preschool program from start to finish and design a guide that will hopefully help other informal science institutions in helping to design an early childhood program.

Limitations

While the program has been successful there were some limitations with the program. The biggest limitation is that the Traveling Programs Department already has a large catalogue for school programming. This catalogue consists of STEM programming for those students in Kindergarten through 8th grade. This is a limiting factor for the preschool program because it became difficult to schedule the program to be booked during the school year. This was talked about in more detail in Chapter Three but is due to the fact that during the school year the main focus for programming had been for Kindergarten to 8th grade students. This meant that the preschool program had to be offered outside of the school year. While the program is for preschool students, this was the best possible solution because most preschool programs are year-round which means the program could be offered and taught during the summer months. While this wasn’t ideal, as Traveling Programs teaches camps and library groups during the summer time, this was the best possible solution for when the program was premiering and could openly be booked by early childhood organizations.

Future Projects

This is just the first out of three preschool programs that will be developed. When this program was first being developed there was a huge interest from preschool teachers to have the Boston Museum of Science travel to their organization to teach a STEM program. During the development of this program, one of the first steps was to send out a survey to preschool teachers that the Museum had a listserv. From this survey I was able to collect the data to see what the top three program topic choices were and other details like what activities and materials teachers would like to see in the programs and the students use. After this initial preschool has been taught, and any last minute changes are made, the development of the second preschool program will start. The hope is that the development timeframe for the second and third preschool programs will be much shorter now that we can take what we have learned during the first program and apply this knowledge towards the other preschool program development.

Conclusion

I have always had a love and passion for science and education. It was through my experiences as a child to my experiences in my professional career that really grounded my belief in how important STEM education is. It wasn't until I started working with early learners that I realized how much younger students could understand and learn. From these observations I knew that I wanted to bring my love of science and my own personal experiences to students of all ages. I wanted to learn about early childhood education and how to design and develop STEM education for this age of students. While there was a huge learning curve into understanding early childhood education I am incredibly grateful for the opportunities that this program development has given me. I hope, if anything, that this project will inspire other STEM educators to look at how they can bring their experiences and knowledge to early learners.

REFERENCES

Atchison, B., & Diffey, L. (2020, January 18). Governance in Early Childhood Education.

Retrieved July 17, 2020, from https://www.ecs.org/governance-in-early-childhood-education/

Baumgart, N. A., & Kroll, L. R. (2018). *Steam concepts for infants and toddlers*. Redleaf Press.

Bouffard, S. (2017). *Most important year - pre-kindergarten and the future of our Children*. Penguin Putnam Inc.

Bowman, B. T. (2003). *Eager to learn: educating our preschoolers*. National Acad. Press.

Cadwell, L. B. (2003). *Bringing learning to life: the Reggio approach to early childhood* *education*. Teachers College Press. Colbert , Judith. (2008). *Classroom Design and How it Influences Behavior.*

Earlychildhood NEWS - Article Reading Center.

http://www.earlychildhoodnews.com/earlychildhood/article_view.aspx?ArticleI=413.

Copple, C., & Bredekamp, S. (Eds.). (2009). *Developmentally appropriate practice in early childhood programs: serving children from birth through age 8*.

National Association for the Education of Young Children.

Counsell, S., Escalada, L., Geiken, R., Sander, M., Uhlenberg, J., Van Meeteren, B., & Zan, B. (2016). *STEM learning with young children: Inquiry teaching with ramps and Pathways*. New York, NY, NY: Teachers College Press.

E, E. (Ed.). (2007). *Naeyc early childhood program standards and accreditation criteria: the mark of quality in early childhood education*. National Association for the Education of Young Children.

Englehart, D., Mitchell, D., Albers-Biddle, J., Jennings-Towle, K., & Forestieri, M. (2016). *Stem play: integrating inquiry into learning centers*. Gryphon House.

Feeney, S., Seefeldt, C., & Galper, A. (2009). *Continuing issues in early childhood education*. Merrill/Pearson.

Gronlund, G. (2014). *Make Early Learning Standards Come Alive: Connecting Your*

Practice and Curriculum to State Guidelines. Redleaf Press.

Hirsch, E. D. (2018). *Why knowledge matters: rescuing our children from failed educational theories*. Harvard Education Press.

Jacobs, G., & Crowley, K. (2007). *Play, projects and preschool standards: nurturing children's sense of wonder and joy in learning*. Corwin Press.

Katz, L. G. (1973). Where is early childhood education going? *Theory Into Practice*, *12*(2), 137–144. https://doi.org/10.1080/00405847309542440

Kemple, K. M. (2017). *Planning for play: strategies for guiding preschool learning*. Gryphon House.

Kostelnik, M. J., Soderman, A. K., & Whiren, A. P. (2011). *Developmentally Appropriate curriculum: best practices in early childhood education*. Pearson Education.

Lange, A. A. (2019, October 14). *Engaging Preschoolers in STEM: It's Easier Than You Think!*

https://dreme.stanford.edu/news/engaging-preschoolers-stem-it-s-easier-you-think

Lange, A. A. (2019). *Teaching Stem in the Preschool Classroom. Exploring Big Ideas* *with 3 to 5 Year Olds*. Teachers' College Press.

Neuman, S. B., Pinkham, A. M., & Kaefer, T. (2012). *Knowledge development in early childhood: sources of learning and classroom implications*. The Guilford Press.