Guide For Designing A New Program For Informal Science Centers

Introduction

This document contains resources on designing a science, technology, engineering, mathematics (STEM) program in order to meet the needs of early learners in non-formal education environments. The resources include:

- How to pick a program
- Developmentally appropriate practice in science learning
- National Association for the Education of Young Children (NAEYC) and best teaching methods
- Next Generation Science Standards and Engineering is Elementary (EiE)
- Program Evaluation
- Preschool Program Outline

The above resources were used for a program that was designed and created for an informal science center (Boston Museum of Science) where the outreach department wanted to broaden their audience from kindergarten through 8th grade to also include preschool (early childhood education).

For some background information, the Boston Museum of Science is an informal science institution located in Boston, Massachusetts. The Museum focuses on STEM education and offers multiple types of educational programming for students in grades kindergarten through 8th grade. Within the education department there are multiple departments that focus on different types of STEM programming. Programming that can be found in the education department within and outside the museum include:

- Traveling Programs: Is an outreach education program that brings the museum's STEM programming to schools (grades kindergarten through 8th) during the school year and to camps and libraries during the summer. Some topics of programming that are taught are: astronomy, engineering, physics, and environmental education.
- Live Presentations: Educators who conduct educational programming for school field trips to the museum and for the general public.Programming for school field trips to the museum are 30 minute classes that are in a lecture format. Programming for the general public include scheduled programs that range from live animals to programs about lightning and electricity.
- School & Youth: Partnership programming between Boston Public Schools and the Boston Museum of Science. This program provides hands-on learning experiences for students in 1st through 3rd grade with Boston Public Schools. Students come to the museum and participate in themed programming within the museum's exhibit spaces.
- Exhibit Hall Interpretation: Programming that is led by instructors on carts throughout the museum. These programs are themed to the exhibit space and will have a hands-on component either by building, using a microscope, making observations and writing them down, or a live animal.
- Exhibits: Throughout the museum there are many different exhibits showcasing STEM topics. In the exhibit spaces there are interactive exhibits where guests can create, build and solve an engineering problem, videos to watch to gain a better understanding of the

topic, and other interactives that allow a more immersive experience either through smell, touch, or hearing.

This guide provides examples of the work of the Traveling Programs Department, which is an outreach educational program for school groups. In terms of outreach, this is the department that takes the museum's STEM programming out of the museum either to school groups during the school year or to libraries and camp groups during the summer. The programming that is brought into schools, which is for students in grades kindergarten through 8th grade, is curriculum based programming that ties into state science standards. In this case, the state science standards this programming is developed around is the Next Generation Science Standards (NGSS) which will be looked at more closely later in this guide.

For the design of this program, the department had multiple questions to answer:

1. What price point will preschool organizations be willing to pay for the program?
2. Is the program developmentally appropriate for preschool students?
3. Does the program fulfill some or all of the NAEYC standards?

With the above questions in mind the Museum’s first preschool outreach program was designed. As this was a new teaching audience for the department, multiple steps were required in designing the program and its effectiveness. It was necessary to understand what programming preschool teachers were looking for and what is developmentally appropriate for this audience.

In this document you will find the following sections:

- ***Section One:*** How to Pick a Program
- ***Section Two:*** Developmentally Appropriate Practice in Science Learning
- ***Section Three:*** NAEYC And Best Teaching Methods

- ***Section Four:*** Next Generation Science Standards (NGSS) and Engineering is Elementary (EiE)
- ***Section Five:*** Program Evaluation
- ***Section Six:*** Preschool Program and Curriculum
- ***Section Seven:*** Conclusion

Section One: How To Pick A Program

When designing a program the first step is usually to pick a topic for the program. When designing a program for an audience This can become more difficult when the audience is one that your department, or organization, hasn't really worked with before. Due to this, when designing a program for a new audience, one of the most important things to help is to get teacher input. The teachers are the ones who best know their age range and will also primarily be the ones booking the program for their students. An easy way of obtaining teacher input is by creating a survey that can be sent out. In Figure 1 is an example of the survey that was used and sent to preschool teachers that the Boston Museum of Science had on a list-serve.

When designing a survey it is important to keep the goals, or questions, in mind. In the case of the Museum's preschool program the questions that were being asked are:

1. What price point will preschool organizations be willing to pay for the program?
2. Is the program developmentally appropriate for preschool students?
3. Does the program fulfill some or all of the NAEYC standards and EEC guidelines?

Having the questions and the goals in a survey that is being sent to teachers is important because it can help guide in the development of the program. As an organization there might be a certain vision for the program but being able to get feedback on those questions and goals from the teachers, who are the content experts, is very valuable. The teachers' responses will help in guiding certain areas of the program development like the topic for the program, what types of activities would be the most beneficial and developmentally appropriate, length of the program, and even cost of the program which is important for an outreach program.

Figure 1. Teacher Needs Survey

Question Asked of Teachers
Organization Name
Your (Teachers) Name
What is your site's zip code?
Which of the following topics would you be likely to book a program on? ● Animals Invertebrates (such as, insects) ● Animals Vertebrates (such as, mammals) ● Soils and Plants ● Lights and Shadows ● Colors and Patterns ● Bubbles ● Motion and Balance ● Health and Our Bodies ● Counting and Numbers ● Building and Engineering ● Five Senses ● Recycling and Being Green ● Weather and Seasons ● Magnets ● Other, please specify
Please select if any of the following elements would be attractive to you in booking a program? ● Listening to a storybook ● Participating in a craft project ● Music or dance ● Costumes or play-acting ● Pre/post activities for teachers to do with students ● Take home items for students ● Other, please specify
What would be your ideal length for a program? ● 20 minutes ● 30 minutes

● 40 minutes ● 50 minutes ● 60 minutes ● Other, please specify
Ideally, how much time in a program should be spent on active, motion-based activity, and how much on sitting/listening? ● 20% moving, 80% listening ● 40% moving, 60% listening ● 60% moving, 40% listening ● 80% moving, 20% listening
What group sizes would work best for your site? ● Less than 10 participants per program ● 10-14 participants per program ● 15-19 participants per program ● 20-24 participants per program ● 25-29 participants per program ● 30 or more participants per program
If we were running multiple programs at your site on one day, would it be possible to stay in one location for all programs? ● Yes, you could stay in one room ● No, you would need to move rooms ● N/A, we would only need one program
How long would it be possible to have uninterrupted access to a designated space (use of the full space without other people there) at your site, including all set-up, break-down, and program time? ● 1 hour ● 2 hours ● 3 hours ● 4 hours ● 5 hours ● More than 5 hours (full day)
Please list the approximate floor dimensions of the space you would most likely use for a Traveling Program: ● Length (in feet) ● Width (in feet)
In this space, is there furniture which would be impossible to move (such as bolted down shelving)?
To serve all of the 2.9-5 year-olds in your school, how much would you expect to pay for our programming? ● Less than $400

● $400 to $449 ● $450 to $499 ● $500 to $549 ● $550 to $599 ● $600 to $649 ● $650 to $699 ● More than $700

Teacher Preschool Program Survey, Boston Museum of Science, 2015.

Looking more closely at Figure 1, it outlines the key questions that were asked. These questions all revolve around the three main questions that traveling programs were asking of this preschool program. Figure 2 outlines a breakdown of each question that was asked in the survey and the reasoning behind the question.

Figure 2. Survey Questions and Reasoning

Question Asked of Teacher	Reasoning for the Question
Which of the following topics would you be likely to book a program on?	When developing a program it is always important to narrow down a topic to focus on. With this question, topic choices were given to teachers in the survey that had been compiled from teacher inquiries about what programs the traveling programs department offered. If this is not the case, where the organization might not have compiled inquiries, the topic choices for this program are also tied into the Museum's exhibit space themes.
Please select if any of the following elements would be attractive to you in booking a program?	Having certain elements, or activities, for a program is important and depending on the age range these program elements are going to look different. By asking this question the Museum was able to gain a better understanding of what teachers thought would be best for their students during and after the program. This question looked closely at what activity might be done during the program so

	that the program is not lecture based (too much talking to the students and no interaction) and what activity could be done after the program to help the teacher in the classroom continue the lesson on their own.
What would be your ideal length for a program?	This question is asked to better understand what is a developmentally appropriate length of a program for students of the preschool age. Most of the Museum's traveling programs, up until this point, offered 50-minute programming for students in kindergarten through 8th grade. However, a 50-minute program might not be ideal for preschool students and the Museum needed to gain better understanding of how long the program could be while keeping the attention of the students. This is an important question no matter the age because developmentally students of different ages can handle longer length programming but also schools usually have to work around a tight schedule.
Ideally, how much time in a program should be spent on active, motion-based activity, and how much on sitting/listening?	Again, this question is focusing more of what is developmentally appropriate for preschool students. For a young audience there needs to be an understanding of how much sit down and listening time there should be and how much interactive educational time there should be. This interactive educational time, depending on the topic of the program, could be listening and playing music, building, an arts-and-craft project, etc.
What group sizes would work best for your site?	Understanding group size is important to know when thinking about the materials that will be needed to build program equipment and the materials needed for the students to use. Also, by knowing the max group size will also better prepare the educators for when they teach the program.
If we were running multiple programs at your site on one day, would it be possible to stay in one location for all programs?	For an outreach program it is important to know the logistics of the site (school) where the program will be taught. For the Museum's programs there are multiple boxes of

	equipment that are brought into the school and setup. If you were to do multiple programs at the same site in one day it would be more beneficial to be able to set up in one location for the whole day. If not, this means that the program equipment will have to be taken down and re-setup in another location at the site. By doing this could take away time from the programs and cause extra stress on the educator.
How long would it be possible to have uninterrupted access to a designated space (use of the full space without other people there) at your site, including all set-up, break-down, and program time?	This question is an extension of the above question and looking more closely at logistics within the site. Ideally, the program will want to be set up in a space where there isn't a lot of other people and noise that can cause extra distraction while the program is being taught. It is also important to know the total time that the space can be used for. Some sites might have before and/or after school programming in the space where the program will be held. If this is the case it can sometimes be difficult to get into the space on time to set up the program which means the educator might need to rush set up or rush to breakdown the program after it is taught.
Please list the approximate floor dimensions of the space you would most likely use for a Traveling Program:	For outreach programming it is important to understand what space(s) is available at the organizations where the program is being taught. Knowing roughly the general floor space that could be used will help in the building of the program equipment. Generally, for outreach programming, the program equipment shouldn't be too large or too much where it wouldn't be able to fit in a space like a school gym or auditorium. However, many early childhood education centers are much smaller than k-12 schools. This means that floor space for program equipment might be limited so knowing this information beforehand is beneficial when thinking about dimensions for the program equipment itself.
In this space, is there furniture which would	This question is an extension of the above

be impossible to move (such as bolted down shelving)?	question that was asked. Due to NAEYC and EEC guidelines (discussed in sections three and four) a lot of furniture in early childhood centers are stationary, or bolted down. This is so that shelving doesn't fall on the students because most shelving in early childhood classrooms are at height and eye level of the student. From a logistical point of view this is important because ideally the program will be able to happen in a space where the furniture could be moved to create an open space, or be able to set up in a space where there is already open floor space.
To serve all of the 2.9-5 year-olds in your school, how much would you expect to pay for our programming?	Most outreach programs have programming where the organizations that are booking need to pay for the programming. Understanding what organizations are willing to pay for a program is important. For the Museum this question was asked to understand if designing a program for a preschool organization would be cost effective for the Museum because building and designing a program could be costly.

Depending on the institution's purpose for the programming this survey can be modified. Again, this survey is for an outreach program where the programming is leaving the museum and being taught within schools. Having questions about program pricing and logistics is also important just as those questions about developmentally appropriate curriculum. Having an overall general understanding for the logistics of the program and the content of the program is both important for the overall design and success of the program. Allowing teacher input from the organizations where this programming will happen is a great incite to what materials and activities the program could include, should include, and design for the program equipment itself.

Opportunities for Collaboration

Teacher surveys are a great tool for understanding the audience and figuring out a new program topic. There are, of course, other ways of choosing a topic for a program. For example, getting input from other departments in the organization that have worked in either the subject area or with the targeted age range is beneficial. As an example, for this program the Traveling Programs Department worked very closely with the early childhood department known as the Discovery Center. As a whole the Boston Museum of Science specializes in STEM education with the exhibits and programming in the main area of the museum targeting those students in grades kindergarten through 12th grade. However, the Discovery Center is an enclosed exhibit space within the museum that focuses on early childhood education. This means the exhibitry and programming in this space are for children of ages 0 through 8 years old. This space allows families with younger children to enjoy the museum in a space that is contained and that is specifically geared toward early learners. While museums do not need to be NAEYC accredited and follow accreditation guidelines, the Discovery Center follows many guidelines that NAEYC would have for early childhood education centers. Some guidelines that the Discovery Center focuses on under guidance of NAEYC include:

- Having a space that invites children to explore, choose activities, and interact with others
- Use strategies that support deeper levels of understanding, like asking children questions to help them dig into what they're studying and encouraging them to come up with different solutions
- Offering children many opportunities to practice social skills
- Create learning activities that respect children's experiences. Books and other resources in the room include characters of different races, ages, abilities, genders, and cultures

- Develop lessons (in this case exhibitry and programming)

While the above bulleted points from NAEYC are only a few of many guidelines for preschool classrooms that the Discovery Center follows a more exhaustive list can be found at: https://www.naeyc.org/our-work/families/what-does-high-quality-primary-classroom-look.

With the collaboration between Traveling Programs and the Discovery Center it was much easier to understand the different needs and challenges for an early learner audience. With this collaboration traveling programs educators were able to work in the Discovery Center and with the educators that work specifically within this exhibit space. This allowed the traveling programs educators to learn some of the programming and activities that take place within the Discovery Center and understand why these activities and programs were beneficial for the early learners that visit the space. Through the hands-on interaction with preschool children it allowed the educators to observe fine, gross, and sensorimotor skills for early learners and they were able to see what type of programming is most effective in helping with these skills. The collaboration between Traveling Programs and the Discovery Center happened during the whole duration of the development of the program.

While collaboration with Discovery was beneficial for understanding the early learner audience and what makes a developmentally appropriate curriculum, another collaboration that can play a vital role in the development of a new program is the Exhibits Department. At the Museum the Exhibits Department are those individuals who design and create the exhibitry that is found throughout the museum's exhibit spaces. Within the Exhibit Department the Traveling Programs Department worked with content creators, as well as, the individuals who build the exhibit components. For this program it was important to work with the Exhibits Department because they helped with the design of the program equipment so that it can be transported from the Museum and from school to school.

Collaboration is a key component when designing a program. By using the resources within the organization it allows educators to work more closely with other departments that they might never have the opportunity to work with otherwise. Working with other departments also means working with individuals who might have a better understanding of the content and building materials that are being asked for the development of the program.

Section Two: Developmentally Appropriate Practice in Science Learning

Developmentally Appropriate Practice (DAP) is a teaching perspective that is commonly seen in early childhood education. With DAP an educator teachers towards the students developmental needs. For early learners these developmental needs include social, emotional, physical, and cognitive skills.For this section the focus is on what is considered developmentally appropriate practice specifically for science learning. Some tips that were useful in the development of this preschool program for science learning included:

1. Value the students questions
2. Explore and find answers together
3. Give students space and time to explore
4. Accept that explorations can be messy
5. Learn from mistakes together
6. Invite curiosity
7. Support further exploration
8. Encourage students to record their observations
9. Invite students to use items at home to further experiment and explore

The above tips for creating a developmentally appropriate science program are suggestions from NAEYC. The reason why these suggestions were the ones primarily used is because while science centers are not and do not need to be NAEYC accredited this program will be taught in those organizations that are. With the other programming in the traveling programs catalog, those programs are all designed with developmentally appropriate practice in mind for Kindergarten through 8th grade. While developmentally appropriate practice for older students can be found in the state science standards early childhood education is different. Early childhood education does not have national or state standards which means that this program follows the NAEYC guidelines for developmentally appropriate practice in science learning. In section three it will look more closely at NAEYC and best teaching methods.

Looking more closely at the suggestions for developmentally appropriate practice in science learning we will look at the reasoning for each of the suggestions and why they might be important when designing a preschool curriculum.

Figure 3. Ten Suggestions for Developmentally Appropriate Practice in Science Learning

Suggestion	Reasoning
Value the students questions	As educators we know to value any question that a student may ask us. While questions asked from preschool students may seem simple but these questions are important developmentally. Having preschool students make observations and then ask questions about those observations is an important lesson in critical thinking and is helping with their cognitive skills.
Explore and find answers together	Being able to learn alongside the students is a great way to get the students excited about the program topic. In relation to the preschool program developed by the Museum exploring

	and finding the answers with the students looks different than what would be seen in a preschool classroom setting. For this program when exploring and finding answers together this means the educator sitting down with the different groups during hands-on activities and helping the students create their designs, or even having the educator create their own design to share with the students. Preschool students are very inquisitive and really enjoy observing what others are doing.
Give students time and space to explore	This is referencing a method of teaching known as free play. Free play is commonly seen in early childhood education and is a time for unstructured learning that is initiated by the student. This free play allows students to use their imagination while allowing them to explore their natural curiosity. While this method of teaching is seen in preschool classrooms it can also be done in an informal program like this program from the Museum. For giving students time and space to explore for this program was done by having an exploration activity during the program. During the exploration activity the students were able to split up into groups and explore the materials that they will be using for the engineering activity that comes later in the program.
Accept that explorations are often messy	Depending on the type of the program could mean that exploration could be messy and this is okay. For example, if the program uses materials that involve water, sand, glue, paint, etc., this could cause a mess. While this might be stressful for the educator what is important to remember is that developmentally preschool students learn the best through these hands-on experiences. By feeling different textures of materials, seeing how different materials interact with one another, and using other senses like smell helps in the students developmentally with gross, fine, and especially sensorimotor skills.

Learn from mistakes together	When learning new things, or trying new things, there are always going to be mistakes that will be made. When students are learning and making mistakes it is good to show the students that mistakes are okay. That it is okay to not understand something right away, or for a craft or activity to not turn out how they might've wanted. Especially in science we learn from mistakes and for teachers and students to learn from mistakes together is a valuable lesson in that the mistake happened but what have they learned from that mistake and what can they improve upon.
Invite curiosity	Curiosity is a great way for students to learn. Students' natural curiosity usually leads them to try new things and to seek out answers to questions that they may have. When developing a program it is beneficial for the educator (teacher) to invite curiosity. Allow students to be curious about the program topic, material, and all of its components.
Support further exploration	This suggestion is very similar to the suggestion above of "invite curiosity." With curiosity comes more observations and more questions from the students. When students have questions about the program it is beneficial for the educator to guide those students in how they could further explore. This could be as simple as suggesting a new material to see if it behaves in the same way, or has the same properties as the first material that was being used. Again, this exploration is going to look different depending on the type of program that is being taught.
Encourage students to record their observations	For preschool students it will be difficult to ask them to write down their observations using words. There are other ways to have the students share their observations. Some examples include having the students circle pictures on a laminated sheet. These pictures could be of different colors, materials, or anything that is being used in the program and that goes along with the program topic.

Invite students to use items at home to further experiment and explore	With non-formal educational programming like with the Museum of Science it may be difficult to have an extension of the lesson for the students to bring home with them. If making little kits to bring home with the students to their families is too costly a solution to this is to have paper handouts or resources on the organizations website that teachers and families can access as an extension of the lesson.

10 Tips to Support Children's Science Learning, National Association for the Education of Young Children, 2020.

While NAEYC is an excellent resource for developmentally appropriate practice for early childhood centers and for non-formal organizations, another great resource is from the National Science Teaching Association (NSTA). For some background information on the NSTA is an organization that focuses on and promotes science teaching and learning for all. Just like NAEYC the NSTA has key principles to help guide in the learning of science among early learners. According to the NSTA these key principles are:

- Children have the capacity to engage in scientific practices and develop understanding at a conceptual level
- Adults play an important and central role in helping young children learn science
- Young children need multiple and varied opportunities to engage in science exploration and discovery
- Young children develop science skills and knowledge in both formal and informal settings
- Young children develop science skills and knowledge over time
- Young children develop skills and learning by engaging in experiential learning

Looking at the NSTA's key principles more closely we can break each of these principles down to understand the reasoning behind the principle. Figure 4 outlines each of the principles and talks about the reasoning for each key principle.

Figure 4. NSTA Key Principles and Reasoning

Key Principle	Reasoning
Children have the capacity to engage in scientific practices and develop understanding at a conceptual level	Usually when thinking of a science curriculum we think of curriculum that is designed and developed for older students. This key principle is pointing out that younger children (preschool students) do have the ability to participate and engage in science curriculum. While the science curriculum might not be as difficult, preschool students are still able to understand basic concepts as long as they are taught at a developmentally appropriate level.
Adults play an important and central role in helping young children learn science	This key principle is looking more closely at the teacher/educator. As an educator it is important to teach in a way that allows the student to design, create, imagine, etc., while learning.
Young children need multiple and varied opportunities to engage in science exploration and discovery	This key principle is stating that students need to be able to explore different things and make discoveries on their own. Having self-guided discovery is important in helping students start to gain and understand critical thinking skills.
Young children develop science skills and knowledge in both formal and informal settings	While this key principle isn't directly related to teaching early learners or design of program curriculum it is a great reminder that students will gain and develop science skills through formal classrooms and through informal settings as well. Informal science settings can include organizations like museums, zoos, and aquariums but can also include experiences outdoors through nature centers and other similar organizations.

Young children develop science skills and knowledge over time	Knowledge of any subject doesn’t happen immediately. It is important to remember this when teaching early learners. For younger students developing science skills and knowledge is going to take time and might take longer than seen in older students.
Young children develop skills and learning by engaging in experiential learning	Allowing students to learn through experience is equally important as learning through curriculum. Learning through experience allows the students to make their own observations and conclusions. This helps with motor and critical thinking skills that are very important at this age to start learning.

Position Statement: Early Childhood Science Education, National Science Teaching Association, 2014.

In Figure 3 and Figure 4 we looked at key strategies and principles for developmentally appropriate practice when teaching science curriculum. While this is important in relation to this program there are other strategies of teaching early learners overall. These strategies are usually labeled as, best teaching methods. For this preschool program we are focusing on the age range of 3 to 5 years old. In the next section we will look more closely at NAEYC and the best teaching methods that NAEYC provides for early childhood education. When looking at best teaching methods this means having a better understanding of what is developmentally appropriate for early learners when developing and teaching curriculum in relation to gross, fine, and sensorimotor skills.

Section Three: NAEYC and Best Teaching Methods

For early childhood education there are no state standards like there are for students in grades kindergarten through 12th grade. Instead, early childhood education in daycare centers, nursery schools, and other early childhood centers use NAEYC guidelines to develop curriculum. Below in this section are resources that were used in helping to understand the preschool age range when it comes to gross and fine motor skills and what is considered developmentally appropriate.

Figure 5. Gross and Fine Motor Skills Considerations

3-Year Olds	4-Year Olds	5-Year Olds
Fine Motor ● Able to place large pegs into pegboards, string large beads, and pour liquids with limited spills ● Build block towers ● Can do puzzles ● Hand coordination leads to quick fatigue ● Draws shapes and objects ● Holds crayons and markers with fingers versus fist ● Can unbutton but does so slowly	Fine Motor ● Able to use small pegs and boards, string small beads in patterns, and pour sand and liquids into small containers ● Builds complex structures with blocks ● Limited spatial judgement (often knocks things over) ● Can manipulate scissors ● Practices activities many times to gain expertise ● Draws combinations of shapes and people ● Lace shoes/clothing but cannot tie	Fine Motor ● Able to hit nails with hammer head, use scissors and screwdrivers unassisted ● Used computer keyboard ● Builds three dimensional block structures ● Enjoys disassembling and reassembling objects ● May confuse left and right ● Can copy shapes and drawings ● Can write first name and make letters that are usually recognizable ● Can zip, button, and tie shoes
Gross-Motor ● Jumps off low steps or objects ● Trouble judging jumping over objects ● Perceives height and speed of objects, but may be overly bold or fearful	Gross-Motor ● Judges well in placing feet on climbing structures ● Develops sufficient timing to jump rope or play games with quick reactions ● Greater awareness of	Gross-Motor ● Skips and runs with agility and speed ● Can incorporate motor skills into games ● Jumps over objects/can jump rope ● Uneven perceptual judgement (may be

● Plays actively and then needs time to rest	limitations and consequences of unsafe behavior ● Increased endurance with long periods of energy ● Can be overexcited and less self-regulated in group activities	overconfident at times but accepts limits and rules) ● High energy levels ● Rarely shows fatigue ● Seeks active games and environments

Gross- and Fine-Motor Development Considerations for Engineering Activities, Boston Museum of Science, 2016.

Figure 5 Reference:

Bredekamp, S., & Copple, C. (1997). *Developmentally appropriate practice in early childhood programs.* National Association for the Education of Young Children (NAEYC).

While there are many resources that are available to understand fine and gross motor skills in preschool students, another helpful resource is NAEYC. In the following table NAEYC was used as a resource to better understand fine, gross, and sensorimotor skills in children of 36 months to entry in Kindergarten.

Figure 6. Motor Skills Assessment Tool

Motor Skill	36 to 60 months	60 months to Kindergarten Entry
Gross Motor Skills	● Walks and runs in circular paths (e.g., around obstacles and corners) ● Crawls through a play tunnel or under tables ● Climbs on play equipment ● Throws large beanbags or ball with some accuracy ● Catches large balls	● Runs with an even gait with few falls ● Hops on each foot separately without support ● Maintains balance while bending, twisting, or stretching ● Walks up and down stairs while holding an object in one or both hands

	with two hands ● Kicks ball forward ● Balances on one foot ● Hops forward on one foot without losing balance ● Jumps on two feet and over small objects with balance and control ● Gallops with skill ● Pedals consistently when riding tricycle ● Walks up and down stairs, using alternating feet, with assistance	● Moves body into positions to catch ball, then throws the ball in the right direction ● Kicks large ball to a given point with some accuracy ● Able to alternate weight and feet while skipping or using stairs ● Throws medium-size ball with some accuracy
Fine Motor Skills	● Eats with utensils ● Uses various drawings and art materials (e.g., crayons, brushes, finger paint) ● Copies shapes and geometric designs ● Opens and closes blunt scissors with one hand ● Cuts a piece of paper on a straight line and on a curve. With blunt scissors, may not cut accurately ● Manipulates small objects with ease (e.g., strings beads, fits small objects into holes) ● Fastens large buttons ● Uses large zippers ● Uses stapler or hole punch ● Completes increasingly complex puzzles (e.g., single, cut-out figures to	● Removes and replaces easy-to-open container lids ● Folds paper and makes paper objects with assistance ● Cuts, draws, glues with materials provided ● Ties knots and shoe laces with assistance ● Prints some letters to own name ● Buttons large buttons on clothing ● Tears tape off a dispenser without letting the tape get stuck to itself, most of the time ● Puts together and pulls apart manipulatives (e.g., legos, beads for stringing and sewing, lincoln logs) appropriately

	10-piece puzzles) ● Writes some recognizable letters or numbers	
Sensorimotor Skills	● Physically reacts appropriately to the environment (e.g., bends knees to soften a landing, moves quickly to avoid obstacles) ● Demonstrates concepts through movement (e.g., imitates an animal through movement, sounds, dress, dramatization, dance) ● Improves eye-hand coordination ● Practices sensory regulation by pushing objects, climbing short ladders, swinging on a swing, and sliding	● Hits a medium size ball (6” to 8”) with a bat with some consistency ● Catches a ball thrown from a distance of five to ten feet ● Manipulates simple puppets ● Carries a glass of water or juice across the room without spilling it ● Enjoys vigorous, active play combined with social constance and game rules (e.g., freeze tag, hide and seek, snow play)

NAEYC Early Childhood Program STandards and Accreditation Criteria & Guidance for Assessment, National Association for the Education of Young Children, 2015.

Even if the program that is being developed is a STEM program, when developing an early childhood program understanding gross, fine, and sensorimotor skills is important. Understanding these motor skills can help in the decision of materials that students can use within the program that are developmentally appropriate for this age range. To better understand materials that are developmentally appropriate and safe for children of preschool age to use an excellent resource is: https://www.naeyc.org/resources/topics/play/toys

It is important to remember that when thinking about a developmentally appropriate curriculum that safety should be a priority. Due to the age of preschool children there are certain hazards that should be taken into consideration. One of the biggest hazards is if there are any materials that are considered to be choking hazards. Some other hazards could include:

- Do any of the materials have any sharp edges
- Will any of the materials cause splinters
- Do any of the materials have pinch points
- Will any of the materials wear and tear easily, and if yes, can these materials be fixed or replaced

Another point to remember when creating an early childhood program in an informal educational setting is that informal education settings cannot be NAEYC accredited. Accreditation through NAEYC follows ten standards that the early childhood organization has to follow. The ten standards that accredited organizations have to follow are: relationships; curriculum; teaching; assessment of child progress; health; staff competencies, preparation, and support; families; community relationships; physical environment; leadership and management.

Up to this point this document we have seen resources for choosing a topic for a new program audience, as well as tools that could be used in observing and evaluating the program and its design. In the next two sections we will look more closely at the preschool audience itself. We will look at resources from the National Association for the Education of Young Children (NAEYC) and other resources for some best teaching methods for the preschool audience in section three. In section four we will look more closely at resources for the Next Generation

Science Standards (NGSS) and why NGSS is important to consider even with a preschool program.

Section Four: Next Generation Science Standards (NGSS) and Engineering is Elementary (EiE)

Like stated earlier in the guide, early childhood education does not have curriculum standards like for students in Kindergarten through 8th grade. Instead, most early childhood organizations follow the NAEYC guidelines for accreditation, developmentally appropriate practice, and curriculum guidelines with a focus on gross, fine and sensorimotor skills. However, while this is a preschool program it was important for the Museum to look at the Next Generation Science Standards (NGSS). This was of importance because while the NGSS don't directly affect the preschool program these are students who will be going into Kindergarten where NGSS will be used and a part of their science curriculum.

When looking at the Next Generation Science there are a couple of different components to look and understand. These components are: Crosscutting Concepts, Science and Engineering Practices, and Disciplinary Core Ideas. Each of these components are defined as and consist of the follow:

- Crosscutting Concepts: These help students to make and explore connections across the four main domains of Science. These domains are Physical Science, Life Science, Earth and Space Science, and Engineering Design.

- Science and Engineering Practices: These practices are to help with inquiry based learning in science and to help with the cognitive, social, and physical practices seen in science and engineering.
- Disciplinary Core Ideas: These are the key ideas or takeaways that are important throughout the multiple science and engineering disciplines. These core ideas are meant to build upon each other as the students progress through each grade level. The core ideas are grouped in the domains of Physical Science, Life Science, Earth and Space Science, and Engineering.

For this preschool program the Traveling Programs Department looked closely at the engineering standards for Kindergarten. From the NGSS website at: https://www.nextgenscience.org/sites/default/files/K%20combined%20DCI%20standardsf.pdf, are the engineering standards that were taken into consideration for this preschool program which Figure 7 outlines in more detail:

Figure 7. Engineering Design Standards

K-2-ETS1 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	Disciplinary Core Ideas	Crosscutting Concepts
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)	**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)	**Structure and Function** • The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)

Engineering Design Kindergarten Standards, Next Generation Science Standards, 2014.

From Figure 7 the Museum looked really closely at the first two standards when designing the preschool curriculum. The reason for this is because this is a preschool program which means that some of the standards might not translate that well into a preschool program. In the case of the last standard that states "analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs," it was decided within the Traveling Programs Department that this would be too difficult to do in a 40-minute program with preschool students.

While looking at the Next Generation Science Standards that were important for the development of the program, the Traveling Programs Department also utilized guidelines from the Engineering is Elementary (EiE) Department at the Museum. As stated earlier in section one the EiE Department focuses on building engineering kits and designing curriculum for students in preschool through 8th grade. Through their curriculum EiE has developed language for an "engineering design process." The steps in the engineering design process are found in the below figure::

Figure 8. Engineering Design Process and Terminology Meaning

Engineering Design Process	Terminology Meaning
First Step: Ask	When starting an engineering design challenge the educator should "ask" questions in relation to the problem that needs to be solved. Some questions to have students consider are: "What is the problem?" "What have others done to try and solve the problem?" "What are constraints?" When asking questions of the students it is important to remember the ages of the students. If this is a program for a younger audience these questions are going to look slightly different. Wording and terminology will need to be changed so that it is developmentally appropriate for a younger audience.
Second Step: Imagine	During this step students should be brainstorming some ideas on what might work best to fix the problem and choose the best one to plan out and test.
Third Step: Plan	Before testing a design it is important to plan out how to create that design. This step allows students to use critical thinking and reasoning skills.
Fourth Step: Create	Once the students have a plan for their design they can then start to build their design. Once the design is finished it is ready to be tested.
Fifth Step: Improve	When the students are testing out their designs this is where the educator can talk to

	students about what is working and what isn't working with their design. Students can then modify or change their design and re-test to see if the changes in design were successful or unsuccessful.

Engineering Design Process and Terminology, Boston Museum of Science, 2016.

The above engineering design steps are those used in programming for those students in grades Kindergarten through 8th grade. Through EiE's evaluation of preschool students the engineering design process for these students was modified. The engineering design steps for preschool students are the following:

- Step One: Ask
- Step Two: Think
- Step Three: Make
- Step Four: Try

It is important to note that the terminology for the steps were changed to be more developmentally appropriate. Using words the students will understand will make it easier for the students to understand what the purpose of each step is and what they are trying to do. There were also two steps of the engineering design process that were taken out. These steps are: Imagine and Improve. The reasoning for eliminating these two steps is to make the engineering design process easier for the students to understand. Developmentally having too many steps in a process for preschool students can become confusing so having a process with simpler steps is easier for them to understand. Even though the two steps were eliminated these steps can be integrated into the other steps. For example, even though "improve" has been taken out of the engineering design process for preschool students this concept is still seen in the "try" step where the preschool students are still building and trying out their designs. When the students are trying their designs the educator can still ask students questions if their designs are working to fully fix the problem. If the design isn't fully working the educator should allow the students to think about what they could do to make the design better to fix the problem in the engineering design challenge.

Now that we have looked at some resources on how to pick a program and what is developmentally appropriate science content and teaching methods, the next section will talk about ways to evaluate a program to see what is successful and what might be unsuccessful. Evaluating a program is beneficial in helping to see what program content and materials are the most useful and which program elements need to be taken out or modified.

Section Five: Program Evaluation

Another valuable piece for designing a new program, especially for a new audience, is understanding what aspects of the program are working and what aspects of the program might not be working as well. When looking at the aspects for the program it can be difficult to know or understand what seems to be working and what is not working. A way that the Museum looked at the program to see what aspects were working or not working was to:

- Observe if the students were able to manipulate the materials for their intended use
- Observe to see if students understand the main goal of the program
- See if students can show their reasoning for their building designs during the program activity

Another way of thinking about how to observe what is working and what is not working for the program is to take the goals that have been written for the program and look to see if those goals are being achieved when observing and evaluating the program. For the Museum, defining what makes a successful program and what makes an unsuccessful program consists of a collaboration between the Traveling Programs Department and the Research and Evaluation Department. Research and Evaluation is a department at the museum that focuses on creating observational and evaluation tools for the museum's public programs and exhibits. Public programming at the museum is programming that happens within the exhibit spaces and in the larger theater (show) rooms. Usually traveling programs doesn't collaborate with the Research and Evaluation Department but as this was a new audience of program development it was necessary to use more formal observation and evaluation tools.

When collaborating with Research and Evaluation there were a couple of steps that were taken for understanding on what the project (program being observed and evaluated) entailed and what information was needed by Traveling Programs to understand the successful and unsuccessful components of the program. From multiple meeting with the Research and Evaluation team it was decided that the following were the key components to observe and evaluate:

Figure 9. Evaluation Questions to be Answered

Question Being Asked	Why Question is Important
How long is each segment, transition, and overall session?	This is an important question because the program length is a total of 40 minutes. When designing a program and all of its components it is important to know that everything will be able to fit in the allotted time frame. If not, the program will either run too short or will be rushed. If the program is too short this is a good indication that there might not be

	enough educational content. Whereas if the program is rushed that is a good indication that there is too much content for the total program length.
Is the timing age-appropriate? i.e. Do children of different ages complete the task in the time allotted?	Because this is a program for preschool students that means there is a range of ages. Usually for preschool those ages are defined as 2.9 to 5 years old. This means that depending on the preschool program, there could be students on the younger end of this range in the same classroom as a student who is on the older end of the range. This question was looking more closely at the activities that happen with the program and to see if the students were able to complete these activities in the time that was allotted. The Museum was looking to see if the activities needed more or less time and if so, how this could be adjusted.
Were overall length of time, overall pacing, and transitions age-appropriate? i.e. How do children of different ages handle transitions between the story and program activities?	This question, while similar to the one above, is looking more at the transition times between each component of the program. This means how long is it taking the students to transition to the story to the first activity? How long is the transition from the first activity back to the story? Each transition is important as this needs to be considered when thinking about the overall length of the program. In this case, the overall length of the program is 40 minutes which means transition times need to be accounted for so that the program isn't rushed or doesn't run over on the allotted time.

Were directions and instructions effective for young/oldest students? i.e. How do children of different ages understand the context of the story and program activities? Do children understand each task?	Giving clear instructions during the program is very important so that the students understand the content that is being taught. If the proper language isn't being used, in this case if the language is too advanced, then the students will be confused and the program goals will not be met. It was important for the Museum to ask this question as this was the first outreach preschool program. This was not an audience that was taught or familiar to Traveling Programs. For any program it is important to make sure that the language being used to teach is age-appropriate so that students aren't confused and might become overwhelmed.
Is the number of options provided age-appropriate for the youngest/oldest students? i.e. Should materials be simplified?	When a program has hands-on components that the students will be using to either build, do an experiment, or manipulate in some way those materials should be easily accessible and easily manipulated by all participants. By evaluating each material used it helped in eliminating those materials that weren't successful and researching others that might be more successful for their intended purpose.

In order to understand the questions that are being asked in Figure 5 multiple observational and evaluation tools were used. In the below figures were two observational tools that were used for this program. As stated earlier this program was designed for preschool students in the state of Massachusetts. The age of preschool in the state of Massachusetts is defined as 2.9 to 5 years old. From the teacher survey (shown in Figure 1) the data showed that having hands-on activities for the students would be the most beneficial. From this data it was decided that having an engineering activity would be beneficial, as engineering activities consist of using different materials to build and solve a problem. Below in Figure 10 is an observational tool that was of the larger educational department whose focus is on designing engineering curriculum for students in preschool through 8th grade. Through EiE's curriculum, school's are able to purchase kits that have a premade engineering curriculum which include a storybook and all the necessary materials that will be needed to solve the problem in the story. While EiE is responsible for designing and creating engineering programs they are also responsible for teaching professional development in teaching the engineering design process to

school aged students. Through EiE's curriculum and professional development assessment tools

which is seen in Figure 6. This observational assessment tool looks at the following:

- Engineering Skills
- What shou see children doing
- How can you help support this skill

In regards to the engineering skills, these are skills that have been developed by the Engineering is Elementary Department at the Boston Museum Science. However, these skills are heavily influenced by NAEYC guidelines as this assessment tool was specifically designed for preschool programming kits that EiE developed. For the purpose of the preschool program that Traveling Programs developed this tool was beneficial when observing and evaluating the two engineering and design activities of the program. The observational assessment tool (Figure 10) outlines the engineering skill that is being observed while giving insight on what the observer should be looking for with the students and how the educator can help students understand the engineering skill that they should be performing.

Figure 10. Observational Assessment Tool for Engineering Skills

Engineering Skills	What should you see children doing?	How can you help support this skill?

Children think about the problem that needs to be solved	• Children refer to the problem at hand when working on the task • Children stay focused on the goal of the challenge and can explain why it is important	• Ask children to tell you what problem they are trying to solve • Ask children to describe how what they are doing will help solve problem
Children investigate the properties and uses of materials	• Children explain the materials they choose in terms of their features (it's strong, it's noisy, it's waterproof) • Children explain why some materials make better choices than others for solving problems	• Ask children why they are using certain materials and encourage them to describe and compare the materials they are using • Ask children if the success or failure of their design had anything to do with the materials they chose to use
Children imagine multiple solutions	• Children try many different ways to solve the same problem	• Focus your comments on the process of creating and how many different ways it can be done • Encourage unique designs and new ideas among your children

Children use the steps of the Engineering Design Process to solve problems	● Children explore materials and think about how they might be used to help solve the problem ● Children develop an idea to solve the problem, try it out, and decide whether it works well ● Children improve their design to make it work better	● Use Engineering Design Process to reinforce the language of "explore, create, improve" ● Use language of the engineering design process to describe what children are doing ● Talk about what steps came before and which steps come after to reinforce the ideas of a process
Children evaluate a design based on how well it meets the goal	● Children focus their comments on how their design functions, not only on how it looks ● Children base their opinions of a "good" design on how well it performs when they test it	● Ask questions that focus attention on how well the design works to solve the character's problem ● Ask children how they might change their designs so that it works better
Children see themselves as engineers	● Children make their own choices as they engage with the materials ● Children recognize that they are helping by solving a problem	● Ask children what materials they think will work well ● Support children to learn from failed attempts ● Ask children how they are helping the character solve their problem

Wee Engineer Observational Assessment Tool, Boston Museum of Science, 2016.

Overall the observational tool (Figure 10) was used more as a guideline of different items to look for when prototyping the program either within the museum or with students in a preschool setting. When looking for more detailed observations for the program as a whole, and not only for the engineering activities, another tool that was used was a Formative Evaluation Protocol. With the Formative Evaluation Protocol participants were asked to be observed. In this case because the participants are children, the legal guardians of the children would be asked to provide assent.

Figure 11. Formative Evaluation Tool

Participant ID:

Staff Leading Activity:

“Have they learned about shadows at nursery school/daycare/etc?”   Yes   No

“Do children understand how to make a shadow?” & “Were directions and instructions, including cards, effective for the youngest/oldest children?”

	Child age/ID	Staff or caregiver question or prompt	Child Initial Response	Staff or Caregiver Prompt	Child Response	Notes
Observation In real time						
Reflection						

Main Idea/Question	Behavioral Question & Observations
“Do children observe the shape of the shadow depends on the shape of the material?	Does the child visibly observe that the object shape creates a similar-sized shadow shape? Yes No Maybe Behaviors observed/evidence:
“Do children observe that the size of the shadow depends on the distance the material is from the light?”	Does a child visibly observe that shape closer to light=big shadow?

	Yes No Maybe Does the child visibly observe that shape closer to the floor=small shadow? Yes No Maybe Behaviors observed/evidence:
“Do children predict how to make a certain shaped and sized shadow?” & “What does ‘predict’ look like with the youngest/oldest students?”	Prediction questions asked and child’s response (behavior observed/evidence) - or- No prediction questions asked
“Is the number of options provided age-appropriate for the youngest/oldest children?”	Any evidence of too many/ too few/ about right number of options
“Were overall length of time, overall pacing, and transitions age-appropriate?”	How many questions did the child get through? Child seems disengaged at what point? Child goes beyond protocol/ innovates/ wants more challenges, etc.
“Can Children build and create a shadow with the building materials?”	Any evidence of motor skill problems with manipulation? Physical problems that come up with building materials? (materials break, etc.)
“Are these appropriate building materials for the preschool age range? (2 years 9 months to 5 years)”	Does the child seem engaged in the materials or disinterested? Behaviors observed Do they use other objects aside from ones offered to make shadows? Which objects/housed:

Formative Evaluation Protocol, Boston Museum of Science, 2017.

For the Formative Evaluation Protocol (Figure 11) it is important to remember that with formative evaluation there should be multiple evaluations done.After each evaluation the data can be used to change details about the program that need to be improved upon, taken out, or added to the program. Formative evaluation is an integral tool to use for the design of a new program, especially for a new audience when there are a lot of unknowns.The Museum's Research & Development Department, whom Traveling Programs worked closely with during the prototyping stages of the programming.Again, utilizing other departments knowledge is a great resource in the development of any program.

Section Six: Preschool Program Outline

The preschool program that was designed for the Traveling Programs Department at the Boston Museum of Science was a program looking at light and shadows. This program topic was chosen based off of the data that was received from the survey that was sent out to teachers (Figure 1). From that survey the program topic, length, materials, logistics, etc., were chosen and used in the development of this program.

At the Boston Museum of Science programs are not scripted, or fully written out. This means programs are not written word for word to then have educators memorize that script verbatim. Instead, all programs are designed with a basic outline that allows individual educators to teach their own program in their own words as long as the general structure of the program stays the same and all educational goals are being met throughout the program. Below is the outline of the program that was designed:

Light & Shadows Preschool Program Outline

Program Length: 40 minutes

- **Story Length:** 15 minutes
- **Activity Length:** 25 minutes
    - Exploratory Activity: 11 minutes

- Engineering Activity: 14 minutes

Program Objectives:

Exploratory activity students will

- Observe/fine the 3 things that make a shadow
- Put things in front of the light and describe the shadow
- Make observations about the different materials and the shadows they produce by testing out the different materials. Some observations that students will be looking for are: dark vs. light, fuzzy vs. sharp shadows, square vs. circle, big vs. small, etc.
- Explore, observe, and predict how to make big/small shadows
- Explore, observe, and predict how to make different shaped shadows

Engineering activity students will

- Explore the materials for which will be good building materials and use their knowledge from the exploration activity (which materials make the best shadows and which materials make the worst shadows)
- Create and build a structure that will create shade for an animal
- Test out the structure that was built
- Change and improve their structure after testing it out to try and make it better

Program Goals:

Exploratory Activity Goals are

1. Students will understand how to make a shadow
2. Students will observe that the shape of the shadow depends on the shape of the material
3. Students will observe that size of the shadow depends on the distance the material is from the light source

4. Students will predict how to make a certain shape and size of a shadow

Engineering Activity Goals are

- Students will go through the engineering design process
    1. Explore: Figure out what materials will be the best building material for their structure
    2. Creating: To build a structure that creates shade for an animal from the story
        - Students will think about what materials to use
        - Think about the size of the structure and what size shadow it will make
    3. Improve: Make changes to the structure to hopefully solve the problem being asked

General Structure of Program:

1. Start program by introducing self, museum, and what the program topic is about
    - ➢ Before starting the shadow puppet play (story), conduct an activity about "what is a shadow?" This activity is very simple. The educator will use a flashlight and make a shadow by using their hands. To have more interaction with the students, educators can have student volunteers make shadows with their hands. By having student volunteers make shadows with their hands this will help to make sure that the group is understanding what a shadow is before teaching the more in depth content of the program.
2. After the "what is a shadow?" introduction, educator can start the shadow puppet play (story)

- ➢ Remember that during the shadow puppet play there will be interactions that consist of movement. This movement will either be hand motions or full body movement from the students.
- ➢ For the story some important things to remember are:
  - The main character(s) will come up against a problem that will need to be solved. From this problem is where the exploratory and engineering activities will happen.

3. For the two activities, exploratory and engineering activities, the educator will start by reading and performing the shadow puppet play. During the play there will be two different breaking points for the activities to happen. For the first break the students will be split into their groups and do the exploratory activity. The whole group will come back together to continue with the shadow puppet play (story). When the character encounters the problem that needs to be solved the students go back with their groups to use the materials that they previously explored to solve the problem in the engineering activity.
4. During the exploratory activity students will be broken up into groups of 2 to 3 students max and explore the materials that will be used to solve the problem from the shadow puppet play. The exploration of materials will consist of using different materials to try and create a shadow. The materials that the students will be exploring will range from different types of blocks that are different shapes and sizes but also have different textures.
5. During the engineering activity students will be broken up into groups of 2 to 3 students max to try and solve the problem from the shadow puppet play. The students will go through the simplified engineering steps which are:

➢ Plan (Think It)

➢ Make It (Create It)

➢ Try It (Test It)

  - While students are working with the materials for the activity the educator will want to make sure to walk around and see the students work (what they are building) and to check understanding. When checking understanding it is useful to ask questions like: “what shape shadow do you think that will make?” “Where could you put your structure to make the biggest shadow?”

6. Once most of the shadow puppet play (story) has been read and both exploratory and engineering activities are completed, students:

   ➢ Will come back together as a whole group. During this time the shadow puppet play will be concluded. The shadow puppet play should finish in a way that all students are involved. Ways to involve all the students include:

     - Having students show what a shadow is. Can use the lights from the program to have students make animal shapes with their hands to showcase their shadows.
     - Have students change the size of their shadows by moving their hand animals closer or farther away from the light source to make the shadows bigger or smaller.

When looking at the above program outline it should be noticed that there aren’t any state standards that the program is following. Again, this is due to the fact that there aren’t state or national curriculum standards for early childhood education. The program was designed while keeping NAEYC guidelines in mind, as well as, Next Generation Science Standards (NGSS). While NGSS are for students in kindergarten through 12th grade, the standards were taken into consideration as to give a basis for the science curriculum that preschool students will eventually learn. In section four is where NAEYC and NGSSwere discussed in more detail and how they relate to the Museum's preschool program.

Section Seven: Conclusion

Overall, designing a program for a new audience can be challenging.This guide went through some of the steps and resources that can be used in helping to design a new program. While this guide specifically focused on early childhood education almost all, if not all, of these resources can be adjusted for an older program audience. When designing a program research of the topic is important but this research can be done in multiple ways. As discussed in section one, using resources within the organization can be very valuable. This could be done through collaboration with other departments that are experts in the content material and collaboration with those who build and design exhibits for within the organization.

For the younger audiences understanding what is considered developmentally appropriate curriculum is also important. What is developmentally appropriate for a student in 1st or 2nd grade is very different to what is developmentally appropriate for a preschool student. There are many resources that are useful in understanding best teaching methods and curriculum for early childhood education. In this guide the resource focused on was NAEYC. While each state has their own Department of Education NAEYC however, is a national organization with set standards and goals and is the reason why this guide looked more closely at NAEYC.

Again, there are many different considerations and steps that need to be taken when designing a program, especially when it comes to a new audience. This guide has highlighted a few that were taken in creating the Boston Museum of Sciences first preschool outreach program. While the process in designing the program was challenging by taking the above steps make the program development process easier.

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