


CREATING A STEM PROGRAM FOR THE GIRLS. INC SUMMER CAMP IN WORCESTER, MA

WPI | Worcester Community Project Center

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TABLE OF CONTENTS

TABLE OF CONTENTS **3**

ABSTRACT **5**

EXECUTIVE SUMMARY **6**

ACKNOWLEDGMENTS **13**

MEET THE TEAM **14**

AUTHORSHIP **15**

1.0 INTRODUCTION **18**

2.0 BACKGROUND **19**

2.1 Imbalances in the STEM Fields 19

2.1.1 Increasing Exposure at a Young Age 22

2.2 Girls Inc. 23

2.2.1 History & Accomplishments 23

2.3. Need for a Summer STEM Curriculum 24

2.3.1 The curriculum objective 24

2.3.2 The Focus 25

2.4 Chapter Summary 25

3.0 METHODOLOGY **27**

3.1 Objective Completion 27

3.2 Ethical Considerations 28

4.0 FINDINGS **30**

4.1 Girls Inc. Findings 30

4.1.0 Finding 1: Large Open Grass Area 30

4.1.1 Finding 2: Camp Kinneywood's Lake 30

4.1.2 Finding 3: Nature Trail Includes Many Animal & Plant Life 31

4.1.3 Finding 4: Worcester Water Filtration Plant Adjacent To Camp Large 31

4.1.4 Finding 5: Many Girls Inc. Participants Have STEM Interest 31

4.2 Best Practices For STEM Education In A Summer Camp Setting 31

4.2.1 Incorporate Short & Engaging Projects With Varying Themes 32

4.2.2 Including Relevant, Real-World Context In Activities 33

4.2.3 Application Of Positive Reinforcement 34

4.2.4 Guided & Structured Inquiry 35

4.2.5 Flexibility 36
4.2.6 A Clear Objective 37
4.2.7 Small Group Sizes 37

5.0 RECOMMENDATIONS 38
5.1 Recommendation 1: WWFP Field Trip 38
5.2 Recommendation 2: Evaluation 38
5.3 Recommendation 3: Training 39
5.4 Recommendation 4: Returning Mentors 39
5.5 Recommendation 5: Garden 39
5.6 Recommendation 6: Future 40

6.0 CONCLUSION 41

REFERENCES/BIBLIOGRAPHY 42

APPENDIX 46
Appendix A: Methodology Timeline 46
A.1 Timeline for IQP 46
Appendix B: Interview Information 47
B.1 Interview Questions and Answers for Ashley Bame, Nature's Classroom 47
B.2 Interview Data Table 51
Appendix C: Focus Group Information 52
C.1 Focus Group Parental Consent Form 52
C.2 Focus Group Questions 55
C.3 Focus Group Data 58
Appendix D: Pilot Study Information 59
D.1 Pilot Study Parental Consent Form 59
D.2 Pre-Survey 63
D.3 Post-Activity Survey 65
D.4 Pilot Study Data 67
Appendix E: Deliverable 68
E.1 Activity Schedule 68
E.2 Ice Cream Activity 69
E.3 Human Senses Activity 73

ABSTRACT

During this project, we researched and interviewed organizations to create environmental science-STEM curricula for the Girls Inc. Camp Kinneywood summer camp. The team conducted focus group and pilot studies to test the curricula and provided a binder containing all activities and information related to the curriculum. The curriculum is flexible while allowing instructors and students to lead the investigations to where they are most interested. It's recommended that surveys are held before and after the program to assess if any aspects of the curriculum need to be modified. It's also suggested that another team evaluates the curriculum in the future as Massachusetts guidelines are updated and changed. New education research is also actively being conducted, so a group can assess the program with new findings which would benefit the students.

EXECUTIVE SUMMARY

Introduction

Women are underrepresented in fields related to science, technology, engineering, and mathematics (STEM), which makes discrimination more frequent against them in those fields. They are often under pressure and mistreated in the work environment, and, on average, many women get paid less than men that hold the same position. One factor in this mistreatment stems from the lack of representation of women in STEM. However, this underrepresentation is not due to weakness or lack of interest in these fields. Rather, research demonstrates that a lack of exposure in those fields at a young age has led to some internal implicit and explicit biases discouraging women from entering STEM careers. To change this, it is important to expose girls to STEM while they are in elementary school; typically at ages where they are seen being pulled from that path.

During childhood, girls are typically seen playing with toys that involve nurturing and art. Whereas boys, during their childhood, play with toys with the functions of building and design, gender-stereotyped toy-play causes the development of different skills. Boys are "practicing agentic roles", while girls are "practicing domestic roles" (Merdan et al., 2022; Pedersen et al., 2022). Thus, giving rise to "boys to prefer[ing] function and task-oriented projects, girls are preferring more contextualized projects, like how technology can help humans" (Merdan et al., 2022; Pedersen et al., 2022). These preferences influence what career paths the kids will want to pursue when they get older and cause girls to dominate in fields that they perceive as helping humans.

Girls Inc. the sponsor of this IQP provides a variety of engaging programs with a vast range of interests, including after--school programs, summer camps, sports programs, and programs that partnered with other community centers, such as the Young Women's Christian Association (YWCA). These programs aim to improve the knowledge and abilities of young women in fields such as science, mathematics, and technology, as well as to instill a sense of financial sustainability in young girls.

The goal of our project was to create a fun and interactive summer camp program for Girls Inc to introduce girls to STEM and teach engineering problem-solving with a focus on environmental sciences. To help achieve this goal, for our interactive qualifying project (IQP),

we had a list of objectives that we followed to make sure our deliverable was the best it could be in a short amount of time.

Methods

To make sure that the STEM curriculum was the best it could be we followed a list of objectives that we developed and they are as follows:

1. Objective 1: Resource Evaluation
2. Objective 2: Understanding Outdoors STEM Education Programs
3. Objective 3: Investigating Interests & Preconceptions
4. Objective 4: Developing a STEM Curriculum
5. Objective 5: The Pilot Study
6. Objective 6: Program Evaluation & Refinement

The first objective was to evaluate what resources we had available to us at Camp Kinneywood as these helped guide us to what activities we would be able to choose when searching for activities, an image of the camp can be seen in Figure 1. Once we completed this we moved to objective 2 where we interviewed a variety of STEM programs that specifically focused on nature and environmental sciences. Some of the places we interviewed were Nature's Classroom, Mass Audubon, EcoTarium, and Hands-on Nature. When interviewing them we wanted to collect data on possible activities we could implement as well as ways to teach these activities, interview questions can be seen in Appendix D.1. Also, we wanted to know what was needed in the lesson plan so they can be understood easily by the camp counselor as we are just developing the curriculum and not implementing it. Afterward, we conducted a focus group to get information on what Girls Inc participants would know and be interested in learning, images of this can be seen in Figure 2 and Appendix C.

Figure 1: Camp Kinneywood

Figure 2: Pilot Study

Once we knew everything we needed, we moved on to objective 5 and develop the STEM curriculum. Since the curriculum had to follow weekly themes that Girls Inc. had developed we added topics the girls would learn about in the themes that can be seen in Appendix E. To make sure that the activities and lesson plans were fun and comprehensible we hosted a pilot study in objective 5. We learned how we can improve our lesson plan to better suit Girls Inc. participants. Lastly, we moved to the final objective and did the final revisions to the lesson plan. We made sure that all the lesson plans were consistent and the best they could be.

Results

After completing all the objectives we discovered certain findings of Girls Inc. and the best practices for STEM education in a summer camp setting. The Girls Inc. findings are as followers:

1. Finding 1: Large Open Grass
2. Finding 2: Camp Kinneywoods Lake
3. Finding 3: Nature Trial Including Many Animals and Plant Life
4. Finding 4: Worcester Water Filtration Plant Adjacent To Camp
5. Finding 5: Many Girls Inc. Participants Have STEM Interest

We collected the majority of the data for these findings in objective 1 where we visited the camp and in an interview with one of the camp counselors. Our evidence to say that many Girls Inc. participants have STEM interests comes from observation and surveys from both the focus group and pilot study. The findings for the best practices for STEM education in a summer camp setting are as followed with an explanation:

1. Finding 1: Students Learn Best Through Activities Involving Hands-On-Learning. This tactic allows for children to become actively engaged while still keeping the activity informative. We first learned this in our interviews where Kathy Chen, the Worcester Polytechnic Institute STEM Education Center's Executive Director, said to give 1% lecture and 99% hands-on activities which were reinforced when we were observing the pilot study.
2. Finding 2: Incorporate Short & Engaging Projects With Varying Themes. It is important to encourage small, quick projects to stimulate activity participants' brains and have them focus on improving their problem-solving capabilities. In an interview with Ashly Bame,

she said that it is important to keep the activity explanation short, preferably five to ten minutes, to keep the participants engaged and their minds focused on developing potential solutions.

3. Finding 3: Including Relevant, Real-World Context In Activities. Applying context to activities can help the girls understand that a lot of STEM jobs can be considered as "helping professions". The use of a relevant, real-world context encourages those in the activity to think with intent, be inherently curious, and make insightful observations (Rachel Quimby)
4. Finding 4: Application Of Positive Reinforcement. To best embrace failure and use that as an opportunity, it is important to use positive reinforcement to guide that process along. Positive reinforcement can be shown in many forms, whether it is through individuals, like mentors, activity framework, or simply some competition.
5. Finding 5: Guided & Structured Inquiry. There are four levels of inquiry and in an interview with Rachel Quimby, she suggested using levels 2 and/or 3. Level 2 is structured inquiry where students investigate a teacher-presented question through a prescribed procedure, and level 3 is Guided Inquiry where students investigate a teacher-presented question using student-designed/selected procedures. These levels allow the girls to both explore options for themselves and learn the most from their failure but also be introduced to new procedures that they might not have thought of on their own.
6. Finding 6: Flexibility. When conducting our interview we asked for some ideas for activities and we got a lot of responses about allowing the kids to go into nature and explore nature themselves, and to be flexible by letting them guide what the instructor teaches. This flexibility is important as it allows the kids to learn in-depth about something they find interesting.
7. Finding 7: A Clear Objective. A clear objective helps the instructor keep the kids on track to learn about what the lesson plan says while also letting the instructor use their judgment for how flexible they can be. Matt from nature's classroom summer camp said that a very clear objective is the most important part of the lesson plan.
8. Finding 8: Small Group Sizes. We learned a lot while conducting the pilot study, one of which was seeing firsthand how much better kids behave in small groups instead of large

groups. In the pilot study, we split the girls into teams 2 and the majority of the girls solved the problem themselves whereas in the larger activity it was harder to get all the girls' attention and focus on the activity.

Recommendations

To make sure that our lesson plan is the most effective we developed some recommendations for Girls Inc. to implement over the next few years.

1. Recommendation 1: We recommend continuing to pursue the opportunity to conduct a field trip at the Worcester Water Filtration Plant to increase exposure. Due to the short duration of this project term, our team wasn't able to organize a field trip to the plant. It will be great for the girls to learn firsthand where and how the local water supply is being protected, treated, and preserved.
2. Recommendation 2: We recommend assessing the program through pre and post-evaluation. As a method to measure student progress and the program performance, we recommend doing a pre-and post-survey after each activity. This makes sure that the developed curriculum is working and is exposing girls to STEM through fun activities.
3. Recommendation 3: We recommend training the instructors for inquiry-based learning. Because we will not be guiding the program this summer, we recommend that the teachers and volunteers receive the training necessary to maintain high-quality inquiry-based learning. Since the lesson plans are flexible and feature a lot of discussion material, instructors must consider how to effectively facilitate each activity
4. Recommendation 4: We recommend having former campers with prior experience of this program return as volunteer counselors. A significant step in ensuring the comfort of the campers and the development of the program is to invite former campers to participate as counselors to help lead the sessions. This would ensure the program's long-term viability since alumni would contribute to its sustainability and younger girls would have a role model to look up to and excel in a friendly learning environment.
5. Recommendation 5: We recommend planting a garden to allow for a hands-on learning environment. A garden is a significant educational resource that may be used for several types of learning, including experiential learning. Experiential teachings provide students

with real-world applications of what they are learning, which tends to make them more interested and involved in the material.

6. Recommendation 6: Have another group look at our activities and make adjustments/updates in subsequent years. Due to the fast expansion and evolution of STEM education, our curriculum must be periodically reevaluated to make it more sustainable and adaptable. In addition, as suggested in recommendation 2, the survey will assist in determining the advantages and disadvantages of the curriculum. so that another party may either build on the strengths or correct the flaws.

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We acknowledge that we would not have been able to complete this project without the support of our advisor, Laura Roberts, who has been instrumental in guiding us down the correct path while working on our project and this paper. We would also like to acknowledge our ID 2050 professor, Alice Plane, who helped us in the initial planning stages of the project. We would like to acknowledge our sponsor Girls Inc. for giving us the opportunity to help the Worcester community and specifically Allison James who was kind enough to give up her time to help us while developing the curriculum by providing resources for the pilot study and focus group. Lastly, we would like to acknowledge all of the people that we interviewed: Zachary Roy, Lisa Carlin, Rachel Quimby, Ashley Bame, Heather Simpson, Matt Caliendo, Donna Taylor, Kathy Chen, Ruth McKeogh.

MEET THE TEAM

Edwin Joseph - Class of 2023 Mechanical Engineering

Edwin Joseph is a rising senior majoring in mechanical engineering and minoring in business management. Some of his similar experience to this project include his involvement in Young Neighbors In Action and his time working as a tutor in RSM. The reason why he did this project is because he wanted to help kids learn and enjoy themselves

Alferid Hussin Shifa - Class of 2023 Mechanical Engineering

Alferid has always been interested in STEM, and is excited to have the chance to share his passions with young kids. Over the term, he had gained a lot of insight from the positive interactions he has had with educators, counselors, and the kids themselves. Alferid really enjoyed working on this project, and is glad he was able to assist Girls Inc. to make a difference in the lives of the young girls.

James Martin - Class of 2023 Mechanical Engineering

James Martin, he is 21 years old and studying Mechanical Engineering at WPI. James don't have much experience working with kids or teaching kids but a similar experience comes from taking WPI's Educational Psychology course. He wanted to do this project because he think it would be important to understand how kids learn.

Victoria Tetreault - Class of 2023 Interactive Media

Victoria Tetreault is majoring in Interactive Media and Astrophysics. Their similar experiences come from their time as a teaching assistant and as a camp counselor. The reason why they are doing this project is because they love working with kids.

AUTHORSHIP

The following report was collaboratively written with four authors: James Martin (JM), Edwin Joseph (EJ), Alferid Hussin Shifa (AHS), and Victoria Tetrault (VT)

Section	Primary Author	Primary Editor
Abstract	VT	AHS
Executive Summary	JM	AHS
Authorship and meet the Team	EJ, JM, VT, AHS	EJ, JM, VT, AHS
Table of Contents		
List of Figures		
List of Tables		
1.0. Introduction	JM	EJ
2.0 Background	EJ, JM, AHS, VT	EJ, JM, VT, AHS
2.1 Imbalance of Women's Representation in the STEM Fields	JM	EJ, VT
2.1.1 Increasing Exposure at a Young Age	JM	EJ, VT

2.2 Girls Inc.	AHS, VT	EJ, JM, AHS, VT
2.2.1 History & Accomplishments	AHS	EJ, VT
2.3 Need for a Summer STEM Curriculum	JM	AHS, VT
2.3.1 The curriculum objective	JM	VT, EJ, JM
2.3.2 The Focus	JM	AHS, VT
2.4 Chapter Summary	EJ	AHS, VT
3.0 Methodology	VT, JM	JM, EJ, VT
3.1 Objective	VT, JM, EJ	JM, EJ, VT
3.2 Ethical Considerations	VT, AHS	VT, AHS, EJ
4.0 Findings	JM	EJ
4.1 Girls Inc. Resource Findings	JM	EJ
4.1.0 Finding 1: Large Open Grass Area	JM	EJ
4.1.1 Finding 2: Camp Kinneywood's Lake	JM	EJ
4.1.2 Finding 3: Nature Trail Includes Many Animal & Plant Life	JM	EJ
4.1.3 Finding 4: Worcester Water Filtration Plant Adjacent To Camp Large	JM	EJ
4.1.4 Finding 5: Many Girls Inc. Participants Have STEM Interest	JM	EJ
4.2 Best Practices For STEM Education In A Summer Camp Setting	EJ	VT
4.2.0 Students Learn Best Through Activities Involving Hands-On-Learning	EJ	VT
4.2.1 Incorporate Short & Engaging Projects With Varying Themes	EJ	VT
4.2.2 Including Relevant, Real-World	EJ	VT

Context In Activities		
4.2.3 Application Of Positive Reinforcement	EJ	VT
4.2.4 Guided & Structured Inquiry	EJ	JM, VT
4.2.5 Flexibility	VT	JM
4.2.6 A Clear Objective	VT	JM
4.2.7 Small Group Sizes	VT	JM
5.0 Recommendation	AHS	VT
Conclusion	VT	AHS
Appendix A: Methodology Timeline	AHS	EJ, VT
Appendix B: Interview information	JM, EJ	EJ, VT
Appendix C: Focus group information	JM, EJ	EJ, VT
Appendix D: Pilot Study information	JM	EJ, VT
Appendix E: Deliverable	JM	EJ, VT

1.0 INTRODUCTION

Society and gender norms direct girls away from pursuing a STEM career. Women make up a small percentage of the science and engineering workforce in 2015 this number was only 28% of the workers (Science & Engineering Indicators 2018). Making up such a small percentage of STEM workers, it might seem that there just are not as many women graduating from college, but women make up on average just over 50% (Science & Engineering Indicators 2018). Instead of pursuing careers in STEM, women are obtaining careers that they believe help people, such as teaching and healthcare where they hold 65% and 75% of the jobs, respectively, in 2021 (World Economic Forum, 2021, pp. 43-58). This caring nature can be affiliated with the skills women were practicing growing up with their toys, such as baby dolls, houses/castles, and cooking sets. In contrast, typically, men possess task-oriented skills as they grew up playing with toys, such as legos, remote control vehicles, rubix cubes, and toy cars. Thus, girls will believe that boys have better STEM-associated skills than they do. Having the mindset of being inferior, causes girls to stay away from those topics and to pursue something that they feel more comfortable with. To help girls not feel inferior, organizations like Girls Inc. provide after only girl school programs and summer camps to learn and grow.

Girls Inc. has locations all over the United States and in Canada, they help underprivileged inner-city girls become strong, smart and bold individuals. This upcoming summer, Girls Inc., of Worcester, wishes to create and run an outdoors STEM program for the summer camp at Camp Kinneywood. In the Methodology Chapter, we will discuss our plan to work with Girls Inc. and create an engaging, interactive, and educational program. The activities will provide the exposure that the girls need to help them feel more comfortable in STEM topics. To complete this STEM program on time, we will first research existing STEM programs to learn about activities they have. With these activities we are able to draft a schedule for Camp Kinneywood. Subsequently, we will test some of the activities we plan to incorporate at one of the after school programs hosted by Girls Inc. To test the activities we will use a pilot study and collect data on the activities to make sure they are fun, safe and informative to the girls. Using this data we are able to revise our schedule to then give it to Camp Kinneywood's counselors to use. The following chapter is the background. It will address the importance of our STEM program and the challenges we might face while creating it.

2.0 BACKGROUND

Women are underrepresented in fields related to science, technology, engineering, and mathematics (STEM), which makes discrimination more frequent against them in those fields. They are often under pressure and mistreated in the work environment, and, on average, many women get paid less than men that hold the same position. One factor in this mistreatment stems from the lack of representation of women in STEM. However, this underrepresentation is not due to weakness or lack of interest in these fields. Rather, research demonstrates that a lack of exposure in those fields at a young age has led to some internal implicit and explicit biases discouraging women from entering STEM careers. To change this, it is important to expose girls to STEM while they are in elementary school; typically at ages where they are seen being pulled from that path.

In this section, we will discuss gender imbalances in STEM fields and workplace differences faced by women in the field. Then we discuss how society views women as caretakers, and the prejudice women face for following a career path related to STEM. We explore the ways in which girls are unintentionally steered away from STEM from an early age. Afterward, in Section 2.2, we introduce Girls Inc. and their mission to help girls through the early stages of life. In Section 2.3, we focus on how Girls Inc. introduce STEM concepts to girls through their summer camp. Finally, in Section 2.4, we explain why teaching girls STEM can be challenging.

2.1 Imbalances in the STEM Fields

There is an imbalance in the representation of women in STEM jobs, compared to that of men. From 2011 to 2012, women from several first-world nations earned more than half of all bachelor's degrees, but fewer than half did so in STEM professions, as shown in Figure 2. Moreover, many first-world countries reported a decrease in the number of women in the STEM field between 2011 and 2012 (OECD, 2016). In the United States, alone, women made up less than 45% of graduates with science degrees, and even less than 25% of graduates with an engineering degree. The lack of exposure women receive to STEM causes them to study other bachelor's programs and seek employment in other fields. Thus, in other careers, such as

education, the representation of women tends to be more dominant, in comparison to that of men (OECD, 2016).

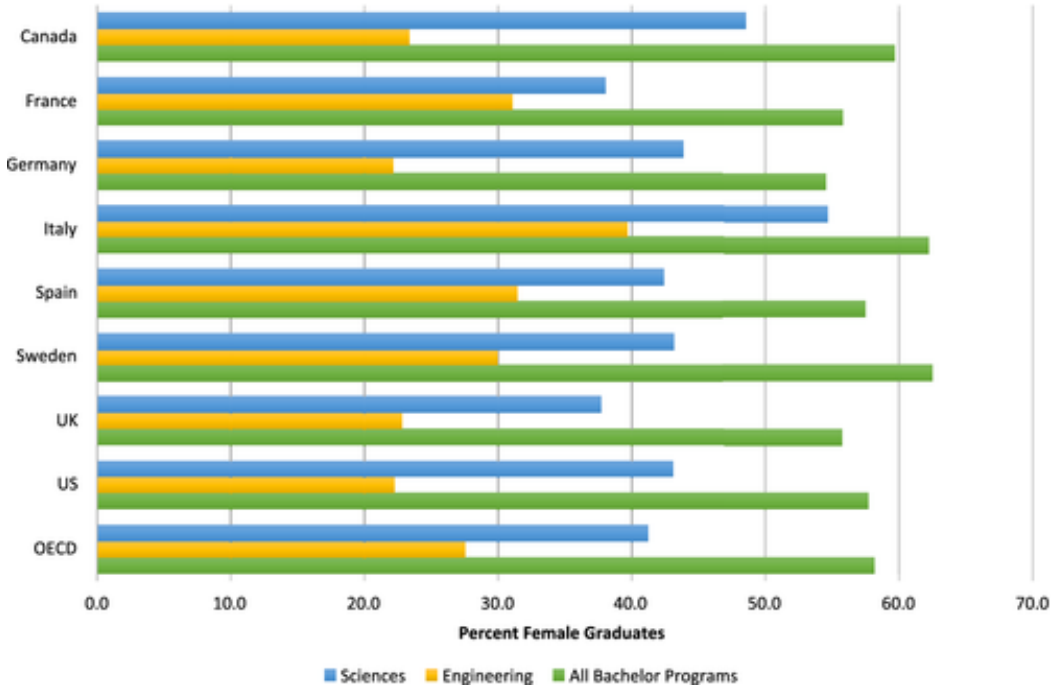

Figure 1: Percent Female Graduates (OECD, 2016)

A 2015 study (Figure 2) found that women in science and engineering make up 28% of the workforce, an increase of only about 5% since 1993 (Science & Engineering Indicators, 2018). Among STEM careers, women are the most underrepresented in Engineering with women making up only 15 % in 2015 (Science & Engineering Indicators 2018). Despite some gains in the workforce and many organizations and universities dedication to advancing women in STEM, gender imbalances still persist. Among the different engineering occupations in 2015, women make up only 9% of mechanical engineers, and 10% to 13% of the workforce in electrical and computer hardware engineers. (Science & Engineering Indicators 2018). STEM occupations consist primarily of Caucasian males, which make up approximately 67% of the STEM workforce. Whereas, people of color makeup, only 30% of the STEM workforce with the lowest representation in engineering at 27% (Denison, 2021).

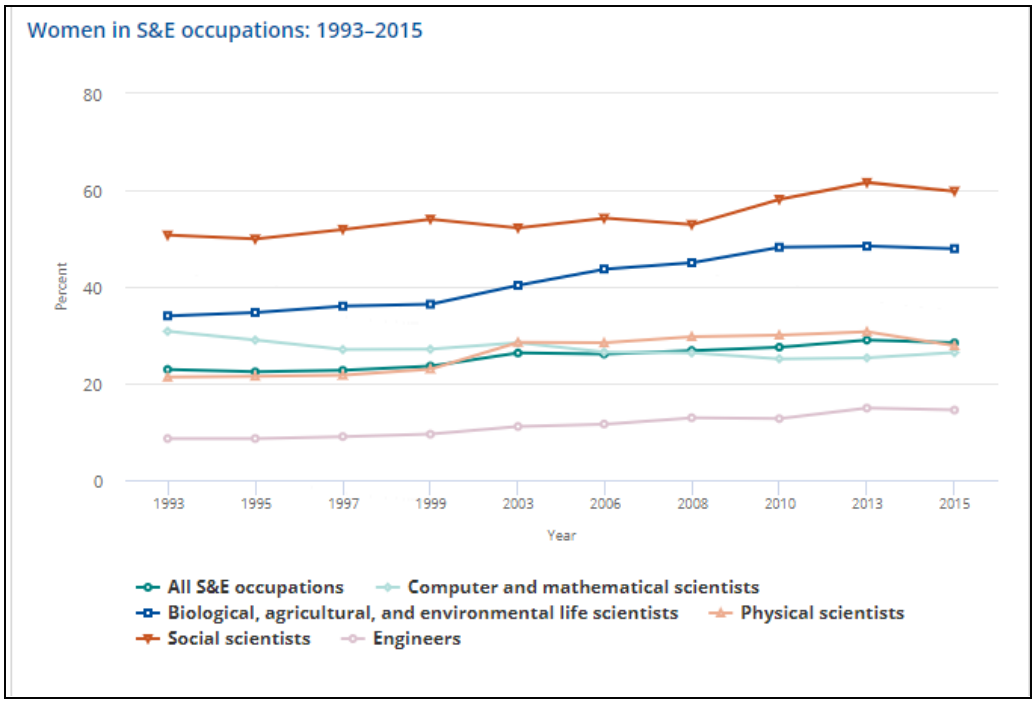

Figure 2: Women in Science and Engineering occupations 1993-2015 (Science & Engineering Indicators 2018)

In addition to being underrepresented in STEM, women are also paid less than men of the same race. A 2019 study shows that Asian women earn on average 14.23% less than Asian men, White women earn 26.93% less than white men, Hispanic women earn 21.92% less than Hispanic men, and Black women earn 17.63% less than Black men (Fry, 2021).

Underrepresentation of women in STEM arises from young individuals' preconceptions of STEM. In a study with high school students, “girls reported lower self-efficacy in math and science compared to boys” (Hand et. al, 2017). By believing they are not better at math and science than boys it makes it harder for them to think they are able to pursue careers that are both math and science-based. “The persistence of horizontal gender segregation in educational and occupational fields contributes decisively to the spread of gender-stereotypic beliefs about a natural fit of women in careers in more expressive and human-centered fields and men in technical and math-intensive fields” (Charles et al., 2009). This ideology has caused girls to seek other occupations that they think suit them better like teachers and content production.

2.1.1 Increasing Exposure at a Young Age

Exposure to STEM at a young age is tremendously important, but girls are not getting enough of this exposure. During childhood, girls are typically seen playing with toys that involve nurturing and art. Whereas boys, during their childhood, play with toys with the functions of building and design, gender-stereotyped toy-play causes the development of different skills. Boys are "practicing agentic roles", while girls are "practicing domestic roles" (Merdan et al., 2022; Pedersen et al., 2022). Thus, giving rise to "boys to prefer[ing] function and task-oriented projects, girls are preferring more contextualized projects, like how technology can help humans" (Merdan et al., 2022; Pedersen et al., 2022). These preferences influence what career paths the kids will want to pursue when they get older and cause girls to dominate in fields that they perceive as helping humans. In a study, a girl drew a picture of "a mother looming over… two girl engineers and their robots, criticizing them for 'making a mess' and telling them to stop" (Merdan et al., 2022; Pedersen et al., 2022). The study came to the inferential conclusion that girls think of engineering as a "messy" job, therefore it is not appropriate for a woman. Whereas in the same study, fathers are portrayed as fixers and builders and they do not concern themselves with this "mess". With toys and parents both reinforcing the stereotype of STEM not being a feminine field, it is more difficult for girls to get the exposure than it is for boys of the same age. Not only is exposure to STEM at a young age very important for girls, but it is also for girls to believe that STEM is not a masculine group of subjects. Girls Inc.'s goal is to get girls ready for future education, introduce them to more STEM-related topics, and show how current and future STEM careers offer services to aid people and communities.

Donna Taylor, the Assistant Director of Professional Development for the STEM Education Director at the Worcester Polytechnic Institute, agrees with the idea that STEM shown to girls influences their preconceptions of STEM. She said "...[N]ot all girls, but [a large amount] girls want to go into professions where they help people. So, a lot of girls don't view engineering as a helping profession….I think we need to change how they view engineering and help them to see [that] engineers are actually making the world into a better place" (D. Taylor, personal communication, April 13, 2022). From her experience, Professor Taylor had formulated that a majority of young girls wish to seek professions that assist and better society by impacting the very people they serve. Not only do girls perceive STEM as an assortment of non-helping fields of employment, but there is also a perception of race involved. In accordance with Professor

Donna Taylor, "....a very stereotypical role is when…[girls]...think of an engineer they think of a white male in a construction hat" (D. Taylor, personal communication, April 13, 2022). Throughout history, the white male has been the dominant figure and that has translated into today's society in such a way that the youth view many fields by a certain race and gender. This further "feeds the belly of the monster" referred to as the stereotype. In order to abolish the stereotype, actions must begin during the youthful times of girls. This would be done by increasing the exposure of STEM to girls at a young age.

2.2 Girls Inc.

Girls Incorporated ("Girls Inc.") is a non-profit organization that is dedicated to addressing the obstacles that young girls experience. This organization focuses on providing the necessary resources to assist girls in becoming their best selves as they grow up and mature. Girls Inc.'s mission statement is to "inspire ALL girls to be strong, smart, and bold"(Girls Inc. of Worcester, 2020). While addressing the economic, gender, and social barriers, they equip young women with the tools necessary to empower, support, and educate them. Specifically, this organization wishes to educate young girls on how to advocate for positive change for themselves and their communities.

2.2.1 History & Accomplishments

Formerly known as Girls Club of America (GCA), Girls Inc. was founded in 1864 in New England. This organization's original mission was to accommodate for the new demographic of working-class women. Girls Inc. This organization's history can be traced back to the Industrial Revolution when young women started to migrate to the northeastern regions of the United States after leaving their family farms to work in the textile factories. The clubs had helped young women who were experiencing hardship, by creating a friendly place where they can gain some practical skills. In 1945, nineteen of these Girls' Clubs joined together to form the GCA umbrella organization (Nicholson & Maschino, 2001). The essential beliefs of Girls Inc. today are the same as those early girls' clubs: to create a safe place and guide young women to be successful.

Since then, the organization has grown to serve many young girls ages six to eighteen through a wide network of program locations. Girls Inc. is present "... in more than 1,500 sites throughout the United States and Canada" (Hull, Personal Communication, 2020). They provided a variety of engaging programs with a vast range of interests, including after--school programs, summer camps, sports programs, and programs that partnered with other community centers, such as the Young Women's Christian Association (YWCA). These programs aim to improve the knowledge and abilities of young women in fields such as science, mathematics, and technology, as well as to instill a sense of financial sustainability in them. Preventing pregnancy and drug misuse are among the other topics addressed by Girls Inc.'s other programs.

Additionally, a growing number of Girls Inc. participants are interested in post-secondary education, with 90% planning to attend college ("SSB outcomes survey report," 2018, P. 9). Such success is a result of Girls Inc.'s outstanding initiatives, such as the Eureka program offered in Worcester and Framingham, MA. This year-round program helps 8th-12th grade females gain confidence, and learn about leadership and academic options in STEM disciplines (Girls Inc. of Worcester, 2020). Girls in the program obtained experiences that prepared them for high school and college.

2.3. Need for a Summer STEM Curriculum

Girls Inc. of Worcester is aware of the challenges that girls experience as they grow up. They recognize that this might have a negative impact on their outlook on their abilities and set low expectations for themselves. More recently, they have decided to expand their summer camp to include STEM-related programs. Those programs will help boost their confidence to thrive and succeed in STEM careers in the future. The program will create an environment where girls feel comfortable learning and growing into women and are not held back by pre-existent mindsets.

2.3.1 The curriculum objective

Women are underrepresented in STEM disciplines due to a lack of access to the knowledge they require to thrive. Girls Inc. of Worcester is focused on the STEM education and

involvement of girls only to provide a STEM-oriented curriculum that girls find most comfortable and find the best-suited environment for those girls.

Women receive only 31% of all post-secondary STEM degrees, but Girls Inc. girls are ready to close the gap, with 72% expressing an interest in learning more about science, computers, or technology. ("SSB outcomes survey report," 2018, P. 10). The programs will be designed to provide alternative ways to introduce and teach girls about topics that they might not learn well in school. To help achieve this goal, for our interactive qualifying project (IQP), we will be developing a STEM program for the summer camp to provide the exposure that the girls need. Our objective is to create a program that will teach the girls some foundational skills related to STEM in an outdoor setting. Through thoughtful and engaging programs that blend both structured and unstructured learning.

2.3.2 The Focus

To create an environment where girls feel comfortable learning, the curriculum being developed will focus on implementing girl-only teams, even though it might be controversial. This exclusion guarantees the girls that they will not be in the minority.

Within these activities, the focus will be on creating projects that are directed toward female audiences by having highly contextualized projects. Creating a girls-only team and combining it with projects that are highly contextualized can assist in greatly increasing the number of female participants in STEM (Merdan et al., 2022; Pedersen et al., 2022). The implementation of such a strategy will have a considerable impact on the girls' attitude and enthusiasm for technology, as well as their motivation to return for more training and experience.

2.4 Chapter Summary

In conclusion, if you want to understand why we are attempting to close the gender gap in STEM fields, try the DAST approach: ask your children or students to sketch what they believe a scientist would look like. The depiction will almost always be of a man.

“....[O]n the basis of the occupational aspirations of 15-year-old adolescents, the prognosis for change in gender-based disparities in occupational and academic choices suggests that gender segregation in the education and labor market will remain persistent” (OECD, 2017).

That was an observation of a survey found in the Global Gender Gap Report. From the perspective of many youths, we will continue to be stuck in a circle of growing disparity. We need to step out of this circle and head for a better path. A path that encourages more girls at an early age to develop an interest in science, technology, engineering, and mathematics. Our team aims to incorporate a hands-on, STEM-based, educational program into a summer camp setting in order to engage and educate the girls at Camp Kinneywood. In addition to outdoor activities, the program will include educational exercises in the fields of science, technology, engineering, and mathematics.

3.0 METHODOLOGY

To help girls get more exposure to STEM topics, Girls Inc. desired a STEM curriculum for the summer camp at the location of Camp Kinneywood. The Methodology Chapter describes the process we took to develop and test the curriculum, this was done by completing objectives we set for ourselves along the way. The objectives were, as followed (See Appendix A):

1. Objective 1: Resource Evaluation
2. Objective 2: Understanding Outdoors STEM Education Programs
3. Objective 3: Investigating Interests & Preconceptions
4. Objective 4: Developing a STEM Curriculum
5. Objective 5: The Pilot Study
6. Objective 6: Program Evaluation & Refinement

3.1 Objective Completion

The first objective was the evaluation of the available resources from Camp Kinneywood and Girls Inc. We did this by going to Girls Inc. and their camp to discover all of the accessible resources, and if resources could be purchased. We knew that Girls Inc. wanted us to focus on nature-based activities so we went on our own nature walk and recorded types of trees, edible plants including mushrooms, and invasive species that could be found around the camp. Upon completion of the evaluation, we were able to discern potential activities.

Then we began our second objective, to interview various outdoor education programs, like Nature's Classroom (See Appendix B). These interviews gave us an understanding of how to create our lesson plans that would best teach STEM in an environmental science setting. After conducting the interviews, we organized the interview data into a spreadsheet with each major topic introduced by the interviewee. Organizing and analyzing the data we collected was an important step in the development of our activities and their corresponding lesson plans, as well as overarching themes that related to the best practices of STEM education in an outdoors environment.because it has made looking at activities and developing the lesson plan untroubling. Once we were satisfied with the number of interviews we conducted, we started researching interesting and educational STEM activities that could take place in an outdoor setting.

Once we had an understanding of how to create a STEM curriculum based in an outdoor setting, we researched what preconceptions and interests the children had about STEM, specifically nature, before creating our curriculum. To do this we conducted a focus group study at Girls, Inc. where we asked the participants about their educational knowledge and interests, in science, nature, and math, as well as their outdoor interests, specifically those of Camp Kinneywood (See Appendix C). After analyzing the focus group data, we developed our curriculum incorporating everything we learned.

As part of our curriculum, we selected two activities to conduct a pilot study (See Appendix D) at Girls Inc.'s main facility in Worcester. We learned a lot from this experience, largely from us simply attempting to put on the study with many children. Using what we learned from this study, and feedback from our project sponsor, we revised our lesson plans.. We accounted for the number of participants , and how easily an instructor might engage their students. Once we finished making the revisions, we compiled the activity schedule, lesson plans, and supply lists into both an electronic file and a physical binder to provide to our sponsor.

3.2 Ethical Considerations

There were a lot of aspects we had to account for when it comes to the ethical considerations of this project and the pilot study. Many of which coincide with the obstacles that we faced while conducting our study. The first considerations we took into account were the parents' consent for us to conduct our focus group and pilot studies. This was a significant factor because the majority of our subjects were minors. We followed guidelines set by WPI IRB in order to ensure that we were in compliance with ethical considerations of all aspects of this project.

The WPI Institutional Review Board (IRB) contributed significantly to the development of the consent forms. With the assistance of Ruth McKeogh, Director of Human Subjects Research and Academic Programs, and Gabriel Johnson, Director of Research Integrity and Compliance, we constructed detailed consent forms (see Appendix C.1 & D.1). The forms outlined how we planned to conduct both studies and provided detailed information about our goal in order to appropriately inform the parents/guardians of our research. We included information such as the study's objective, the benefits of the study to the participants and others,

and the record-keeping and confidentiality of all data obtained by us or anyone else in the research. To maintain confidentiality, it was necessary to keep the subject's information anonymous when handling the data from the responses and when conducting pre-and post-activity surveys. In addition, we included information regarding the minor's willingness to take part in the study. We underlined that the decision to participate in those activities is ultimately up to the child or participant. If they did not wish to participate, we conveyed alternative procedures or activities that will be available. Finally, we explicitly ask the parents/guardians for permission to use the photographs we took - from the least intrusive angles to protect their privacy - in our report and website. Working closely with the IRB has assisted us in accounting for those considerations, and with a lot of collaboration and meetings with the IRB, we were able to gain approval with the IRB reference number 22-0645. (see Appendix C.1 & D.1)

4.0 FINDINGS

In this section, we discuss the findings that we developed from the completion of our objectives. We classified our findings into two categories: Girls Inc. findings and the best practices for STEM education in a summer-camp setting. Our findings pertaining to Girls Inc. included the resources that Camp Kinneywood had to offer and the STEM-related interests that the Girls Inc. participants have. Our findings in regards to the best practices for STEM education in a summer-camp setting include ways to help engage the girls so that they learn the most from every activity, and therefore have positive exposure to STEM. These findings focus on what to include in an activity and a lesson plan.

4.1 Girls Inc. Findings

In this section, we dive into the resources and findings of Girls Inc. The qualitative data collected came from Objective 1, Resource Evaluation where we conducted a field study and an interview with Zachary Roy, the Activity Director for Camp Kinneywood, and from Objective 5, a pilot study.

4.1.0 Finding 1: Large Open Grass Area

When entering Camp Kinneywood the first thing you see is a large open grass area, this allows us to include large activities such as bottle rockets that need an area to allow the rocket to land in. This large, open area allowed for us to include a few game-oriented activities, where running around in large areas is vital.

4.1.1 Finding 2: Camp Kinneywood's Lake

Camp Kinneywood has a small lake which allows us to incorporate different types of activities. In our interview with Zachary Roy, we discovered that the girls are able to go swimming in the water and use canoes to row around on the water. Being able to use the lake, in and on it, meant that we didn't have to disregard any water activities.

4.1.2 Finding 3: Nature Trail Includes Many Animal & Plant Life

In our interview with Zachary Roy, at Camp Kinneywood, we were told about a trail that encompasses the lake. This trail allows for multiple access points to the edge of the lake and the girls can use this trail to find different animals in different parts of the surrounding woodlands and the lake. The trail also allowed for the development of nature exploration activities where the girls are able to go into nature allowing them to experience a different environment than they normally would.

4.1.3 Finding 4: Worcester Water Filtration Plant Adjacent To Camp Large

In a meeting with Allison James, we were informed of a water treatment facility next to the camp. This facility could be used as a field trip to allow the girls to learn firsthand about the scientific process to make the water they drink every day.

4.1.4 Finding 5: Many Girls Inc. Participants Have STEM Interest

When conducting the focus group, we asked the girls what their favorite school subject was, and 55% of the girls said mathematics was their favorite subject (See **Appendix C.3**). Although such a high percentage, there was mention of playing a lot of computer math games, which could be why they enjoy math so much. This might disprove our finding in the pilot study, however, when we asked the girls if they found the human-senses activity fun, 88% of the girls that we asked said that it was a fun activity (See **Appendix D.4**). When people are interested in a topic, they process information "more efficiently" and are able to make connections between old and new knowledge (Paul). The majority of the girls in 3rd grade were able to work out the goal of the activity. They could not taste skittles when they closed their nasal cavities, from just making a connection between the taste before and after they blocked their nose. This connection and the data collected from the focus group proved that Girls Inc. participants have STEM interests.

4.2 Best Practices For STEM Education In A Summer Camp Setting

From the accumulation and analysis of the conducted interviews with Nature Summer Camps and the WPI STEM Education Center, the Focus Group Study, and the Pilot Study, we generated six vital practices for successful STEM education in a Summer Camp setting.

4.2.0 Students Learn Best Through Activities Involving Hands-On-Learning

The first vital practice is the incorporation of Hands-On-Learning. This tactic allows for children to become actively engaged while still keeping the activity informative and educational. “Hands-on learning is where instructors engage with students in direct experience and focused reflection to enhance students’ knowledge, skillset, and values….[It] allows students to learn through experiencing something and can give them an opportunity to immerse themselves in a learning environment, while putting their acquired skills to use and building new skills” (“Hands On Learning”).

This tactic is imperative to keep the girl engaged, especially during the summer. Children want to be active and do not wish to be engaged in school-related situations,they do not wish to be in a lecture-oriented environment, where they are sitting around and listening. They wish to be active and keep their hands moving. This was apparent when conducting our focus group study. Of all of the subjects, 50% enjoyed playing outdoors (see **Appendix C.3**). So it was important to develop activities that meet the educational parameters of Nature and STEM, while keeping the girls active and engaged.

We found this to be true when we conducted our pilot study. One of our activities was an activity that involved movement. This activity was called the Human Senses Activity. The objective of this activity was “[t]o explore how…the girls’...senses work and to realize that our senses are able to do different things and some change what our other senses are” (see **Appendix E.1**). To achieve this goal an element of the activity was to explore the heart rate, and to do so the girls were instructed to run around. After conducting this activity, we conducted some post evaluation. The results from this activity conveyed that approximately 83% of the participants enjoyed this activity and 83% learned from this activity. This evidence further adds to the claim that Hands-On-Learning is important to the success of an activity and to the participants enjoyment.

In accordance with the expert opinion of the Worcester Polytechnic Institute STEM Education Center’s Executive Director, Kathy Chen, it is imperative to give them 1% lecture and 99% hands-on activities (see **Appendix B.2**). With the inclusion of Hands-On-Learning in activities, it allows the activity participants to individually identify the problem and create solutions, reinforcing their problem-solving capabilities in an enjoyable manner.

4.2.1 Incorporate Short & Engaging Projects With Varying Themes

The best way to reinforce problem-solving and to apply hands-on-learning is through the incorporation of short and engaging projects with varying themes. It is important to encourage small, quick projects to stimulate activity participants’ brains and have them focus on improving their problem-solving capabilities.

To create the most ideal short-project-activities, it is vital that the lesson plans be sectioned off. The lesson plans must include sections such as: a material list, an objective, key

points, instructions, guiding questions, a reflection, a timeframe, and a context. It is important to keep the activity explanation short, preferably five to ten minutes, to keep the participants engaged and their minds focused on developing potential solutions (Bame, 17 May 2022). This quick-paced organization allows for the project-activity to proceed smoothly, yet it is important to incorporate a sense of simplicity for the participants, while including specifics and be clear for the instructors (Quimby, 18 May 2022). It is imperative to differentiate between the two to best simulate a problem-solving scenario for the children. Doing so minimizes confusion and directs focus to the task at hand.

Exercising varying themes is a vital part of developing and conducting activities. Children wish to be active and engaged, when in a summer camp. So, when incorporating STEM education in activities, it is important to revolve the activities around varying themes. Such action allows for stimulation of participants' creativity and imagination, allowing for further enjoyment and effort in activities. The best way to enforce thematic variability is through the use of the activity's context.

4.2.2 Including Relevant, Real-World Context In Activities

In the purpose of creating activities under the pretext of STEM education, it is optimal to apply a context that consists of human elements, is relevant to the environment, emulates the real world (Quimby, 18 May 2022). The use of real-world context, allows for the activity participant to apply the context and imagine a scenario where they are in a precarious situation, assigned a role, or helping in a specific manner (Taylor, 25 May 2022).

The use of a relevant, real-world context encourages those in the activity to intently think, be inherently curious, and make insightful observations (Quimby, 18 May 2022). These three functions are important in maturing children's intelligence and education, as they simulate the components necessary for success and for creating solutions.

One way to develop such a context is through the use of visuals and the element of a humane backstory. Using visuals, such as images and videos, helps participants visualize the parameters and imagine the scenarios behind the activity. For example, in an activity where the girls in Camp Kinneywood are given the role of engineers, it is very helpful to use images and videos of female engineers (Taylor, 25 May 2022). This allows for the girls to gain inspiration, potentially insight, and increased imagination as they conduct the activity, ultimately furthering their progress and cultivating their mind-growth.

Another way is to pull in human elements, such as a backstory, on how the elements of the activity help others (Quimby, 18 May 2022). Also, as stated previously (see Background Chapter), girls tend to seek opportunities of employment that are geared to helping others. This is a primary reason why many do not choose the STEM path when entering the workforce. To improve the conceptions of STEM, as a grouping of professions that *do*, in fact, help others, it is important to include a backstory that focuses on helping other individuals, society, animals, plants, and other elements of the environment. Thus, the girls participating in the activity will

gain the realization that there are many occupations that encompass STEM that are specifically geared to helping others, thus making a positive impact on the world.

The emphasis on real-world experience, real-world problems, and other instances in the world allow for the participants to gain some background or experience into a certain scenario. It also allows for the participants to focus on some important aspects of life, particularly seen in the STEM world, failure and success. With the use of such context, it allows for the possibility that sometimes things do not go as planned. It is important to reinforce that failure is not the end, rather it is important to embrace failure as an opportunity and not as an end.

4.2.3 Application Of Positive Reinforcement

To best embrace failure and use that as an opportunity, it is important to use positive reinforcement to guide that process along. Positive reinforcement can be shown in many forms, whether it is through individuals, like mentors, activity framework, or simply some competition. The use of mentors allows for the introduction of role models to the children. The addition of a positive role model allows for children to learn from their mentor's past experiences, opinions, and knowledge and embrace some elements as their own. This provides them with an influence to better themselves and perform at higher levels. In the sense of conducting activities, having a positive influence through an instructor allows for the activity participants to become more engaged, more adaptable to failure, more focused on the methods of success, and more educated on certain aspects of that activity.

These four elements produced from the application of a positive role model, can also be produced from the use of healthy competition. Having competition is a very good method of engaging children in activities. Competition feeds the idea of improvement and doing better than their peers, for participants to succeed in an activity. The use of "healthy" competition encourages the idea that failure is just a phase to grow. It introduces the idea that there are a multitude of practices that allow for the achievement of a goal, and if a practice is ineffective, there are other ways to achieve said goal. Hence, there is an intent to focus on improvement and success.

To influence this behavior of the children, it is good to incorporate rewarding activities. Often competitive activities involve cooperation and teamwork. It allows for collaboration with different types of people, developing a sense of adaptation between the group depending on certain strengths and weaknesses. Such rewarding activities should be subjected towards how well individuals work best as a team, simulating the real-world essence of many occupations (Taylor, 25 May 2022).

However, it is essential that activities do not have a primary emphasis on competition. Healthy competition is important for STEM-geared activities, but is important to steer the children's focus away from the aspect of winning (Carlin, 19 May 2022). Too much focus on competition, specifically the drive to win, steers the participants away from the true objective of the activity: the educational purpose. It is important to use competition as a way to fuel their education and intellectual growth.

This can be done by incorporating the drive to learn with the aspect of competition. The drive to learn is essential in influencing the children's educational prowess and knowledge. This can be done by the culmination of guidance being both hands-on and hands-off. Hands-on guidance can be achieved by gently steering the children. The hands-off portion would be having them drive their own education (Quimby, 18 May 2022). The use of both guidance methods allows for a synchronous activity where the children feel as if they are leading themselves and each other through the activity. An example of this could be by letting the kids find something they are interested in and then talk about that and "expand their mind on that topic" (Caliendo, 23 May 2022). Engaging the children's interests and expanding upon that interest allows for increased engagement and will to learn, ultimately improving the effectiveness of the activity.

4.2.4 Guided & Structured Inquiry

How exactly can an instructor be both hand-on and hands-off in an activity? This can be done through the presence of guided inquiry and structured inquiry in an activity lesson plan. In total there are four levels of inquiry, which are divided "....based on the amount of information and guidance the teacher provides the students" (*4 Levels of Inquiry*, 2014).

The first level of inquiry is called confirmation inquiry. This inquiry level focuses on confirming a known principle from the conduction of an activity (*4 Levels of Inquiry*, 2014). Activities that incorporate this level of inquiry use traditional-style labs, where the children are told to follow a specific set of instructions and perform a task or experiment to yield results that are consistent with the known principle. The use of this level of inquiry is important from an educational standpoint, however having this as a sole part of the activity, would be consequential. Such a traditional method, is similar to a school-environment, and these children participating in a summer camp would prefer to stray away from such an environment. Rather it is important that some elements of confirmation inquiry are embedded into the activities. The incorporation of confirming known STEM principles, consistent with the educational framework of the participant group, is essential in educating the group while still leaving some openness.

The second level of inquiry is called structured inquiry. In this level of inquiry the children investigate a question presented by the instructor with the use of a prescribed procedure (Quimby, 18 May 2022). Activities that incorporate this level of inquiry use methods of investigation to yield results. The results stem from the open-ended question presented by the instructor. There is no predetermined answer (*4 Levels of Inquiry*, 2014). Rather the conclusion from the activity is gathered from the investigation of the activity participants. This is an extremely useful level of inquiry as it is imperative to have self-exploration for the children to mature and grow with their own strengths. In STEM activities, especially in a summer-camp setting, the use of structured inquiry is essential in the education aspect of activities.

The third level of inquiry is called guided inquiry. In this level of inquiry, children investigate a question given by an instructure, and develop and implement their own strategy and

procedure to develop an answer or solution (Quimby, 18 May 2022). Activities that incorporate this level of inquiry use the essence of self-guidance. There is "[n]o predetermined method…" to achieve the objectives of these particular activities, rather the participants "....must determine how to investigate the problem" and how they plan on creating and implementing a viable solution (*4 Levels of Inquiry*, 2014). This enforces a sense of independence amongst the participants, and allows for personal guidance to further interests and education regarding STEM.

The fourth, and final, level of inquiry is called open inquiry. In this level of inquiry the children would investigate questions that they, themselves, postulate, and devise their own methods of determining and enforcing a solution (*4 Levels of Inquiry*, 2014). Activities that incorporate this level of inquiry use a similar essence of self guidance. However, dissimilar from the third level, the children are not given an objective or a specific pursuit, rather they come up with their own using their curiosity, interest, and drive to learn.

Utilizing only one level of inquiry is inefficient when developing a successful activity. It is wise to incorporate elements of each level, to ensure the activity reaches its full potential of entertaining and educating the participants. There should be a decent balance when incorporating the levels of inquiry into an activity. According to Rachel Quimby, the Public Program Coordinator of EcoTarium, it is recommended to incorporate two to three levels of inquiry, to attain a successful activity lesson plan. For example if an activity relied solely on…

- …confirmation inquiry, the activity proceedings would be unentertaining for both the audience and the instructor.
- …structured inquiry, the participants might lose the drive to complete the activity and lose focus.
- …guided inquiry, where the children had to develop their own plan of attack, they may run into much confusion, and the instructors may not be able to assist.
- …open inquiry, the instructors might have ended up losing the attention of the children, as the children are responsible for progressing the activity, and they may not know exactly what they want to do, or how they want to do it.

It is also important that not all of the levels of inquiry are present in the activity. This would cause much confusion for the instructors who are responsible for implementing the lesson plan. It is important to use two to three of these inquiry levels, specifically applying the combination of guided and structured inquiry, possibly coupled with another level. The combinations of inquiry levels is dependent on the objective, context, and proceedings of the activity and it is important to be flexible with the elements of incorporated inquiry levels.

4.2.5 Flexibility

It is important to recognize that the activity may not proceed as planned. It is highly likely that the activity comes under uncontrollable and controllable variables. So, it is important to be flexible with any and all aspects of an activity. This is something that became apparent

throughout the testing of activities and interviews (Caliendo, 23 May 2022). Flexibility not only allows for activities to keep going, even if something doesn't go as planned, but also allows for the activity to go where the kids are most likely to learn the most. If you follow where the kids are most interested, you'll often find they learn more.

Children are curious by nature, and have short attention spans. This was very apparent during our focus and pilot studies. This means that without peaking their interest, it'll be hard to keep an activity going. Having flexibility allows for some key things to happen. The first of which is that it can foster teamwork, as the kids begin to explore with each other, finding things out together. When kids get to take their own path, it allows you to build off of that, seeing what they already know, are interested in, and what they're curious about. With this curiosity from their exploration, will of course come with many questions. Let the children identify and create solutions to either the problem or question. Those tiny connections add up, and get them excited about everything else going on when they make them (Caliendo, 23 May 2022).

4.2.6 A Clear Objective

One thing that was made clear to us, is that objectives must be concise, and make sure there's no confusion surrounding the objective of the activity (Caliendo, 23 May 2022). When the objective and instructions are too obtuse, people inevitably get confused about what they're meant to be doing. This applies to not only the children, but also the instructors. A long confusing set of instructions will lead to mistakes, and doesn't allow much room for further personal research, or flexibility in what the kids find the most interesting.

4.2.7 Small Group Sizes

Small groups for activities are also extremely important. As opposed to large groups, it makes sure each individual has a part in the activity so they don't feel left out. It also makes talking to each of the girls easier, as with larger groups children will distract each other, and some will attempt to hide in numbers. With smaller groups, as opposed to activities done individually, also means that the children get to work on their teamwork and communication skills. It also allows for when you ask them questions, and attempt to guide them, they may bounce off of eachother, facilitating more small connections for them to grab on to. It was found through the pilot studies that groups larger than 5 tended to distract one another, and difficulty began to arise. However, for final reflection questions, discussions, etc it may be beneficial to have everyone in the group there. This is because the activity is finished by this point, and they've already focused on it, so a group discussion where they talk about what they did and learned, will go smoother than when doing the activity itself (Caliendo, 23 May 2022).

5.0 RECOMMENDATIONS

Based on our research and findings, we prepared a series of recommendations for the future advancement and sustainability of the STEM camp program. These recommendations are intended to be utilized to improve the overall quality of the program that Girls Inc. of Worcester offers.

5.1 Recommendation 1: WWFP Field Trip

To increase the exposure and understanding of the water treatment and filtration processes and the profession itself, we recommend implementing small field trips or trips to the Worcester Water Filtration Plant that is located near the camp. The field trips will improve and expand the curriculum and will increase the girls' subject knowledge and community awareness.

Due to the short duration of this project term, our team wasn't able to organize a field trip to the plant. It will be great for the girls to learn firsthand where and how the local water supply is being protected, treated, and preserved. If a visit to a local treatment plant is not possible, we recommend showing the water treatment plant tour video, such as the "How Worcester Works-Water Filtration Plant" presented on the worcesterma.gov website or securing a guest speaker from the plant to come and talk with the campers.

5.2 Recommendation 2: Evaluation

As a method to measure student progress and the program performance, we recommend doing a pre-and post-survey after each activity. Since the activity conforms to the Massachusetts STE standard, it will be beneficial to utilize DESE model feedback instruments and to add questions as necessary. The DESE model also includes a subset of prompts in a discussion format for grades K–2, which is far more effective than giving a survey to the younger children.

Our team has created a sample pre-and post-survey, which was delivered during the pilot session (See Appendix D.2 & D.3). Although the surveys were only used in two pilot sessions, the assessments proved valuable in determining the success of the sessions. In addition, the Massachusetts Department of Elementary and Secondary Education has developed a rubric to assist instructors in evaluating the quality, rigor, and alignment of lessons and units to the 2016

MA STE Curriculum Framework. We recommend utilizing this rubric to track the program's progress.

5.3 Recommendation 3: Training

Because we will not be guiding the program this summer, we recommend that the teachers and volunteers receive the training necessary to maintain high-quality inquiry-based learning. Facilitating inquiry-based learning necessitates adequate training, and often unlearning, on how to effectively direct a lesson plan. Since the lesson plans are flexible and feature a lot of discussion material, instructors must consider how to effectively facilitate each activity. For instance, we designed certain activities to include discussion throughout, so the instructors must be able to guide each camper down their learning paths.

There are several training seminars available to assist instructors. Mass Audubon, for example, provides virtual and in-person professional development programs for active participation and practical application. Their Workshops are intended to expand curriculum understanding, offer instructors hands-on STEM-focused learning experiences, and practice with instructional tools. They employ inquiry-based education to assist instructors in meeting standards and aligning curricula. There are also other training and development opportunities available if Girls Inc is able to acquire a grant. For example, the four winds nature institute coaching seminar for outdoor teaching professional development. Their website not only provides lectures but also additional resources and lesson plans for various activities.

5.4 Recommendation 4: Returning Mentors

A significant step in ensuring the comfort of the campers and the development of the program is to invite former campers to participate as counselors to help lead the sessions. This would ensure the program's long-term viability since alumni would contribute to its sustainability and younger girls would have a role model to look up to and excel in a friendly learning environment. Where the campers will get the opportunity to collaborate with someone to whom they can immediately relate. In addition, this is a fantastic opportunity for the returning campers to gain from the camp's emphasis on leadership development, which is one of the goals of the program.

5.5 Recommendation 5: Garden

A garden is a significant educational resource that may be used for several types of learning, including experiential learning. Experiential teachings provide students with real-world

applications of what they are learning, which tends to make them more interested and involved in the material. For example, one of the activities that are included in the program is planting a plant, and if the camper has a garden, they will be able to witness the results of their hard work for a considerable amount of time in the future.

5.6 Recommendation 6: Future

Due to the fast expansion and evolution of STEM education, our curriculum must be periodically reevaluated to make it more sustainable and adaptable. In addition, as suggested in recommendation 2, the survey will assist in determining the advantages and disadvantages of the curriculum. so that another party may either build on the strengths or correct the flaws.

6.0 CONCLUSION

After gathering research and lesson plan material, we designed an 8-week STEM curriculum that corresponded to the weekly theme, with a few key elements included in each activity lesson plan. Each of these activities, as well as any associated materials, are provided within a single binder for convenience. This binder includes resources such as a schedule, master supplies list for all activities, and instructions for each activity (See Appendix E).

Each activity's lesson plans have objectives that are in line with Massachusetts STE learning standards. These are meant to assist instructors on what each activity should be focused on teaching the children. These are a big part of the curriculum we've crafted, as when an instructor knows what is being targeted, directing the activity becomes easier. We've also provided resources for each activity, which are a good place to start if the instructors wish to do their own research, but it's not required. The lesson plans are all based on flexible inquiry-based learning and small groups of children as was stated in the findings section.

The schedule allows for the instructors to plan ahead, and see how each of the activities interconnect with each other. Seeing the interconnectivity of each of the activities can help the instructors understand the overarching goals of each week. These goals enhance the learning experience by giving direction to the activities, and let the instructors direct the conversation in a specific direction.

Lastly there's a master list for all the materials for the activities, this is an estimate, and instructors are encouraged to use their own judgment. Instructors will know better on what will get used, what can be reused, and what can't. However, the list gives a starting point for instructors to go off of. Both the schedule, and the materials list, while seemingly small additions, improve the quality of the activities tremendously, and their ease of implementation.

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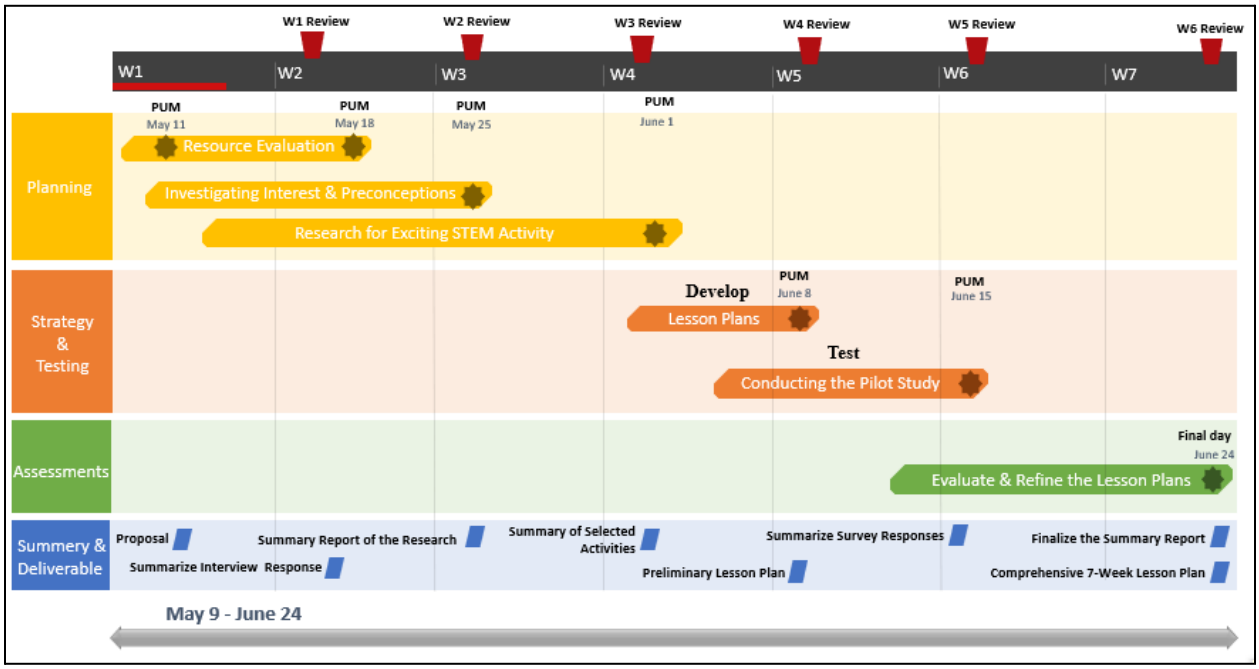
APPENDIX

Appendix A: Methodology Timeline

A.1 Timeline for IQP



Appendix B: Interview Information

B.1 Interview Questions and Answers for Ashley Bame, Nature's Classroom

Introduction:
"Hi, I'm…."
"We are rising seniors at WPI. We are currently doing a school-sponsored project, called the Interactive Qualifying Project (or IQP for short), with Girls Inc. here in Worcester. We will be creating a STEM program for a summer camp called Camp Kinneywood. This is a summer camp for girls from Kindergarten to Sixth Grade. Our responsibility is to create an informative and engaging program that changes themes each week."

Questions:

1. *"Would it be alright with you if we audio-recorded this meeting?"*
    a. Got permission to record
2. *"What inspired you to join nature's classroom?"*
    a. Joined 2004, fell in love with the program after seeing what they did for the students. Took urban students to a unique outdoor setting was inspiring, and stayed.
3. *"We have seen on your LinkedIn profile that you held the positions of associate director and program coordinator in Nature's Classrom. What is your role as a coordinator and associate director and what are your responsibilities with them?"*
    a. Program coordinator incharge of teaching staff, 22 instructors. Day to day schedule.
    b. Loves the community aspect of her role. She is training the teachers on how to give instructions.
4. *"What do you enjoy most about your roles in nature's classroom?"*
    a. Community as well as helping teachers grow, especially with teachers first engaging with employment.
5. *"On the website, it says nature's classroom works with kids 10-17 years old, does nature's classroom work with kids 5 years old and up?*
    a. *Probe: "Have you personally had any experience working with kids in kindergarten to 6th grade?"*
    b. 5 is a little young. Starting maybe at age 6, youngest at 3rd grade. Dont work byond 8th grade.
        i. No experience teaching young kids, was a swim instructor.
6. *If she worked with kids K-6: "In your opinion, what are the best methods to teach kids STEM?" (build off it more)*
    a. *Probe: "From your experience, what hands-on learning tactics for an outside environment have you used that have seen a positive response from kids?*
        i.
    b.
7. *"Are you familiar with girls inc?*
    a. *If yes, " have you been involved with Girls Inc. in the past?"*

8. *"As you may know, we will be working to create a program for young girls. This program will take place primarily outdoors in a camp setting. What parts of nature did you find girls most engaged in?"*
    a. Not much difference in girl and boy interest, see how humans interact with the world. See where natureal is related to the human world. When kids find animals it doesnt matter the gender. In team building, normaly boys take the leadership role. Have to help quit kid more generally girls. Give and take with the different roles for kids. 12-1 ratio
9. *"When teaching kids outdoor STEM, did they seem to learn better while individually working or with groups/teams?"*
    a. Team settings tend to work better, but try to give students some say as well. Larger groups and smaller groups both work well, encourages teamwork. Theirs are very instructor based. 70% science to 30% social, emotional learning, teamwork. Genereally no less than 60-40.
10. *"When working together, how were the kids' group dynamics?"*
    a. *Probe: "Did kids normally cooperate?"*
    b. *Probe: "How should these groups be divided? Should we let them choose or should we choose ourselves?"*
    c.
11. *"In your experience do you think girls work better with instructions or open-ended assignments/activities? Why?"*
    a. ***Example of open-ended: build a zipline. Instructions: tell them how to build a zipline***
    b. No students sit well thorough a lecture. Quick introductions and visual aids such as finished product. Blend of ways to get information. As instructor they go around and help the kids, like basic stuff. Giving all the directions up front would be boring.
12. *Do you have any suggestions for outdoor Nature activities? Particularly an activity that lasts at most an hour. What are your favorite activities?"*
    a. *Probe: "What hands-on teaching activities have you used that respond best to girls' learning?"*
    b. Minimal knowledge, high engagement.
        i. Shelter building, whether tiny sub structure or a larger one to relate to animals (Gnoommmeeesss)
        ii. Engage and ask questions about why they do it
        iii. Camoflauge and stalking activity
        iv. Anything that gets them out, foraging for edible things
        v. Safety/Field guides
        vi. Identification of shrubs, trees, let them use tools to use their new knowledge

1. **dichotomous key**

vii. Kids get excited by making little connections
viii. Human physiology can be done for water, how fast you swim, breath rate, pulse, etc.
ix. Map and compass collections/traveling over the lake over various points. Possible make a fire pit, or anything else. Cache's in the woods, end result should be memorable (camp fires, smores, hot dogs, etc)

13. ***"We will be creating activities for girls, split into 2 groups: K-2 and 3-6. Some of the activities we plan to use for the girls in grades K-2, we also wish to modify for grades 3-6, and vice versa. What are some things that we would have to consider when modifying the activities?"***
    a. *Probe: "Any specifics you have run into, recently or in the past?"*
    b.
14. ***"Based on your experience as a program director, what are some criteria for activity instructions that you believe made it easier for the counselor, and for the kids?***
    a. *Probe: "Anything you found that the kids liked or understood? Anything they did not?"*
    b. *Probe: "To our knowledge, the camp counselors at Camp Kinneywoood are not particularly familiar with conducting a STEM curriculum. What are some things that we could use to help/train them? "*
    c. *Probe: "What have you found most helpful? What should we avoid when training?"*
    d. Definitely schedule a time during orientation, present it as if the staff are the team of kids. Some of the staff wont know the material. Having something ritten up would be good. Objectives, key points to talk about, activity explanation. Conclusion (5-10min).
15. ***In your professional opinion do you think it is ok for kids to pick up wild animals such as fish, salamanders or frogs?***
    a. *Probe: "Are there any particular precautions we need to be conscious of?"*
    b. Yes it is ok to pick up, instruction the teacher on student behavior, the rock placement is the animals home. They breath through there skin so no bug sprey and get hands dirty before hand. Replace rock to where it was before, place animal near the rock, not under. Have a small terrarium so other kids who cant go on walk to see then release them later. WATCH the kids they want to take them home, make sure they dont lick the animals.
16. ***"Do you have any resources we could have access to, to help us find activities that we would be able to use?"***
    a. *Probe: "Would it be possible for you to send out a list of some of your activities for us to reference?"*

b. Clear with director before they share with us (class write ups) and they can be modified. Check up later incase we don't hear back about the resource sharing.

17. ***"Do you have any other advice for us as we begin to develop our curriculum?"***
    a. NO
18. ***"Can you recommend anyone else that would be good for us to speak with about our project?"***
    a. Summer camp director, adventure camp, summer camp aspect of stuff, matt
19. ***"Can we contact you in the future if we have additional questions?"***
    a. *Probe: "What is the best method to contact you?"*
    b. Yes, can always call or email works as well.
20. ***"Is there anything else you would like to share with us?"***
    a.

B.2 Interview Data Table

#	Name	Organization	Kids Ages	Girls Interest	Group dynamics		Teaching style			Activity Ideas		Safety
				Part of Nature Girls Engaged In	Individual vs Team activitys	Kids Cooperation	Instructions or Openended	Criteria for Lesson Plan	Best Methods to Teach kids STEM	Nature	STEM	Precautions to be consider
3	**Ashley Bame**	Natures Classroom	3rd grade to 8th grade	No differeance between Girl and Boy interests	Teams are better, make sure every kid has a say.	works well both small and large groups, 70% sciance and 30% social learning	NO lectures, quick introduction with a visual aid and then instructor goes around asking more specific questions. Answering all quesions up front is boring.	Objectives, key points to talk about, activity explanation. Conclusion (5-10min).		- Picking up animals and putting in a tarrarium for a day - shelter building - camofouge and stalking - foraging for edible things -using fuild guides to identify stuff	- human physiology, pulse before and after running around. - Map and compass to collect differnt things to then do something fun	Yes it is ok to pick up, instruction the teacher on student behavior, the rock placement is the animals home. They breath through there skin so no bug spray and get hands dirty before hand. Replace rock to where it was before, place animal near the rock, not under. Have a small terrarium so other kids who cant go on walk to see then release them later
4	**Rachel Guimby**	EcoTarium	Preschoolers to 12 Grade	Different girls like different things, having challenges and being tasked with finding things are great	A balance between the two is good	Younger kids have trouble truly collaborating, and older are better	open style is best, and guided inquiry based instruction. Focus on the level of inquiry at most at lvl 2 or 3	It should be simple, have guiding questions, materials list, timeframe. Be very specific and clear for the teachers and not so much for kids	Inquiry based learning, and encourage kids to be curious and make observations. Gently steering them and the learner is driving their own education. pull in human elements such as a back story on how it will help others.	- Make a bird feeder - Insect program and scavenger hunt - Compare our senses to other animals, ex owl.	- DNA bracelets or digits of pie bracelets - Collect pond water and look it under a microscope - Test water with PH strips. - Activity revolving around our 5 senses	
5	**Matt Callendo**	Natures Classroom Camp	4th to 11th grade	Everything		Every group is different, a good impression/feel comfortable the kids tend to react better.	too much instructions and they loose interest, letting the kids find something they are interested on and then talk about that and "expand there mind on that topic"	Simple, step by step, what you want to get out of the activity. Be specific about what the ultimate goal is but the process to the ultimate goal can be very vague. Safety concerns included.	Keeping it as simple as possible and keep the door open. Letting the kids take their own path and explore on there own.	- Building a damn - Dissecting animal poop - Gnome home building out of nature	- Building a stomp rocket -	training the camp staff before the activitys so that they know how to help the kids the most, like asking them questions and exploring ont here own.
6	**Lisa Carlin**	Mass Audubon	K to 10th Grade			Team building at begin is very important	Mix of both, focusing on Guided inquiry instruction	Break it down into times and have the goal and objective. Include materials, step by step and extra info for the stuff is helpful. Having picture and visual aid is good too	Competition is good, just don't focus on winning. Havin 2 things that we want to learn, not too much info at once.	- Population studies on what is in the pond, scooping and stuff. - Identifying Bird while kayaking. - looking at is invasive species	- Marble runs - Building with boxes - Built a rocket ship with boxes - Buld a beaver damn	
7	**Heather**	Hands on Nature	PreK to 9th grade	Like soft and fluffy things, like bunnies and chicks.		assigning teams helps kids not feel left out	handing the kids instructions is not good	Start with something the kids already know and build off it. Back up activitys if you finish early. Going into more depth with the older kids about the plants like its seeds and stuff.		- drawing birds they see, helps them see more detail in the bird - using field guide to look at different plants and animals. - walking slowly to see if something sparks their interest - Bug hunt using bug boxes, have a small magnafine glass on the top - using micronets to catch animals in the water	- volcanos -	
8	Donna Taylor	WPI STEM Education center	Middle school to post-secondary		team works best, and a small groups of 2-4 are good. For younger kids are best in pairs	have activity that rewarding how well they work as a team.	Inquiry based, and letting them have autonomy.	Incorporate starde eductional framework, and include the objectives and learning targets based off the standards	Add some real world context, applying it and make them think. There curiosity drives the learning. Shares images or videos of female engineers . Also embrace failure. give positive encouragement	- Let them brainstorm idea on how do we clean up the ocean - Design a musical instrument in the woods.	- have activity of understanding food webs and food chain	
9	Dr. Kathy Chen	WPI STEM Education center	Middle school to post-secondary						give them 1% lecture and 99% hands on activities. Making them identify the problem, and create solution	- Building a birdfeed and home for bird that won't allow squirels to eating too much bird food		

Appendix C: Focus Group Information

C.1 Focus Group Parental Consent Form

Parental Consent Form

Introductions

Hello, we are students at the Worcester Polytechnic Institute who are conducting a pilot study for Girls Inc. in Worcester, MA. This summer, Girls Inc. wishes to incorporate a program involving STEM (Science, Technology, Engineering, and Mathematics). Girls Inc. wishes to increase and improve the girls' impressions of STEM. Thus, in the coming summer of 2022, we are creating a summer camp program to engage these girls. It is our duty to create this program in helping both Girls Inc. and the girls participating in the program.

We would like to conduct a focus group involving your Girls Inc participate to help create and improve this summer camp program. We will be conducting a focus group to gain an initial understanding of how the participants (other girls/students of grades K-6) perceive STEM. We will be conducting a group question-activity with two groups: grades K-2 and grades 3-6, at Girls Inc. This activity will take approximately 1 hour, in which we will split the girls up and have them answer each question on a large paper/poster. Towards the end of the activity, the girls will have the option to draw a scientist on a piece of paper using coloring utensils, which we will collect upon completion. This will all be included in our research analysis, but the responses will remain anonymous. This will involve questions about their interests and pre-conceptions in STEM. Pictures and videos might be taken during the focus group so that we are able to include pictures in our presentation and final report. The pictures and videos will be from angles so that the child's face will not be in the picture.

If at the time of the STEM activity, your Girls Inc. participant wishes to not participate in our research, Girls Inc. will provide activities for them as part of their after-school program

COVID Guidelines. We understand that COVID is still a large concern. In this focus-group study, we will all be masked and we will be following the Girls Inc. policies for COVID. We will follow the Symptom Tracker that Girls Inc. uses, and proceed with the necessary precautions.

In an emergency Girls Inc. will use the contact information they already have to contact you.

APPROVED BY
WPI IRB 1
5/12/22 to 5/11/23

Child Information

Full Name:_____ **Age:**_____ **Current Grade:**_____

Consent

TO WHOM IT MAY CONCERN:

Filling out all the below spaces does hereby give consent for our (my) child, _____, to attend and participate in a focus group. This study and activities will be sponsored by the **Worcester Polytechnic Institute** and **Girls Inc. of Worcester, MA** from **May 11, 2022,** to **June 24, 2022**.

Pictures and videos might be taken during the activity and the surveys. These pictures would be included in our presentation and final report, which will be posted on the digital.wpi.edu website and the wp.wpi.edu/wcpc website. The pictures and videos will be from angles such that the child's face will not be visible. The audio and, potentially, the visuals from the videos, would be used to further our research and data collection for our study. The pictures, audio, and videos will be securely stored in a password-protected Google Drive folder that only we will have access to. **I (We) consent for my Girls Inc. Participant's pictures to be taken and presented in our research report**:

☐ No ☐ Yes

If your child does not wish to attend the focus group, Girls Inc. will provide them with alternative activities, during the time of our activity.

For any questions and concerns about the research please contact us at gr-GirlsInc-F22@wpi.edu.

☐ By checking this box and typing my name below, I am electronically signing this consent form.

Parent/Guardian Signature:_____

Relation to Student:_____ **Date:**_____

APPROVED BY
WPI IRB 1
5/12/22 to 5/11/23

NOTICE:

In the event of an emergency, Girls Inc. will contact you with the emergency contact information you have provided them.

Questionnaire

1. **Does anyone in your Girls Inc. participant family work in any STEM (science, technology, engineering, math) jobs or working to get a STEM degree? If so, who?**

2. **Is your Girls Inc. Participant getting exposure to STEM (science, technology, engineering, math) out of school? If so, what kind of exposure is she receiving? How is she receiving this exposure?**

3. **What does your Girls Inc. participant wish to be when she grows up?**

C.2 Focus Group Questions

Focus group Questions

1. **Ice Breaker:**
    a. What's your name?
    b. "What grade are you in?"
    c. Favorite food that starts with the same letter of your first name
    d. Favorite animal?
        i. We record answer on paper
    e. Next person repeats previous person's/people's response and then answers the question
        i. For grades 3-6
2. **Favorite school subject?**
    a. We Record answer on paper
    b. Why?
3. **Out of these science topics (on the table) what do you all know?**
    a. Run through each and see how many they know
    b. Record the how many know which topic
4. **What are your favorite topics in science?**
    a. Why?
    b. We Record answer on paper
    c. Already would have a selection, which they can mark (i.e. star or heart)
    d. If they do not see the one that they like, they can also write it down
    e. Biology, Chemistry, Physics, Animals, Dinosaurs, Ocean, Human Body, Weather, Rocks, Space, Measuring, Plants, Other
5. **Out of these math topics (on the table) what do you all know?**

a. Run through each and see how many they know

b. Record the how many know which topic

6. **What are your favorite topics in math?**

   a. We Record answer on paper

   b. Why?

   c. Already would have a selection, which they can mark (i.e. star or heart)

      i. *Addition/Subtraction*
      ii. *Multiplication/Division*
      iii. *Fractions/Decimals*
      iv. *Counting*
      v. *Algebra*
      vi. *Word Problems*
      vii. *Percents*
      viii. *Ratios*
      ix. *Equations/Inequalities*
      x. *Graphing*

   d. If they do not see the one that they like, they can also write it down

7. **What are your 2 favorite pieces of tech? Why?**

   a. If they just say phones or don't know what to say. For the younger kids (K-2), give them examples:

      i. 3D Printer/Printer
      ii. VR headset
      iii. Xbox/Playstation/Gaming Console
      iv. Car
      v. Stove
      vi. Hearing aid

vii. Fridge

viii. Stethoscope (heartbeat thing)

ix. Air plane

x. Boat

xi. Lights

xii. phone/iPad

b. We Record answer on paper

8. What's your favorite thing about the outdoors?

a. We Record answer on paper

9. What's your favorite thing to do at camp Kinneywood?

a. We Record answer on paper

10. If you could build one thing, what would it be?

a. We Record answer on paper

b. Option to draw on paper, as well

11. What does STEM stand for?

a. Give them an index card with:

S_____ T_____ E_____ M_____

b. Talk about it and then collect the cards

c. Explain what STEM means

12. Draw A Scientist.

a. "We have 10 min left, draw your best scientist on this piece of paper"

b. Give the kids a piece of paper and coloring tools

c. Collect the papers/take pictures

C.3 Focus Group Data

1	**Name**	**R**	**A**	**J**	**A**	**C**	**A**	**A**	**C**	**J**	**C**
2	**Grade**	2	2	2	2	2	2	3	3	5	5
3	**Animal**	Cheetah	Bunny	Dog	Giraffe	Elephant			Lion & Wolf	Parrot	Dog
4	**School Subject**	Math (*smart*)	Tech (*Computer*)		Math	Outside	Math	Math	Math, Sports	Lunch	Science (*experiments*)
5	**Science Knowledge**	Ocean, Plants, Animals, Physics	Ocean, Plants, Animal, Rocks, Space, Human Body		Animals, Plants, Ocean	Animals, Plants, Ocean	Animals, Plants, Ocean	Animals, Plants, Ocean	Dinosaurs & Animals	Plants, Human Body, Weather, Space, Measuring, Ocean, Animals	Plants, Physics, Animals, Dinosaurs, Ocean, Human Body, Weather, Space, Rocks, Measuring
6	**Favorite Science**	Human Body	Plants		Animals	Animals	Animals	Animals	Animals	Measurements (*it's easy*)	Rocks
7	**Math Knowledge**	Addition/Subtraction, Multiplication, Counting, Fractions	Percentage, addition, counting		Subtraction, Multiplication, Fractions	Subtraction, Multiplication, Fractions	Subtraction, Multiplication, Fractions	Subtraction, Multiplication, Fractions	Subtraction, Multiplication, Fractions	equation, addition, multiplication, fractions	Equations, Graphing, Addition/Subtraction, Multiplication/Division, Decimals, Word Problems, Counting, Fractions Negative Numbers
8	**Favorite Math**										
9	**Favorite Technology**	iPad	Computer	Counting number game				Robots	Puzzle	iPad	Laptop
10	**Outdoor**	Playground	Playground	Playground, tag	Relax			Lakes	Games	Hiking	Kayaking
11	**Camp Kinneywood**	S'mores		Playing	Water				Water	S'mores	Kayaking
12	**Build**	S'mores	House for ladybug	Tiny house for dog			ST Math	Robot House	Gumball Machine	Own dance company	
13	**STEM**	Science Team Eats Muffins		Science Tech Engineering M?				**Science Technology E? Math**		Say Tech E? Math	
14	**Draw A Scientist: Male or Female?**	Female	Female	Female			Female			Female	

Appendix D: Pilot Study Information

D.1 Pilot Study Parental Consent Form

Parental Consent Form

Introductions

Hello, we are students at the Worcester Polytechnic Institute who are conducting a pilot study for Girls Inc. in Worcester, MA. This summer, Girls Inc. wishes to incorporate a program involving STEM (Science, Technology, Engineering, and Mathematics). Girls Inc. wishes to increase and improve the girls' impressions of STEM. Thus, in the coming summer of 2022, we are creating a summer camp program to engage these girls. It is our duty to create this program in helping both Girls Inc. and the girls participating in the program.

We would like to conduct a study involving your child to help create and improve this summer camp program. We will be conducting a pre-survey to gain an initial understanding of how the participants (other girls/students of grades K-6) perceive STEM. We will, then, conduct Ice Cream Making and Senses activity with the girls in hopes of improving our instructions for the lesson plans; and at the same time provide your child with an enjoyable experience. All of the activists will be surprised by a Girl Inc. staff member at all times.

In the Ice Cream activity, your Girls Inc. participant will explore the process of freezing, in which they will be creating ice cream inside of a bag. While conducting this activity, we will considering food allergies that the participate may have and we will providing option for them. We will be providing option such as lactose-free dairy products. In the Senses activity your Girls Inc. partipant will explore how objects have different sounds and try to identify them. Then using touch and feel to calculate their heart rate before and after running. Then there will be a taste activity, in this your Girls Inc. participant will explore how smell effects there taste by eating skittles. The activities will take a total of 2 hours and depeding on circumstances we might change the entire nature of the activity we are conducting. The content of this activity is currently in development, and will be further developed from your *Girls Inc.* participant's feedback.

Finally, we will give out a post-survey to examine and analyze the effectiveness of our activity, in hopes of improving the activities and program. The surveys we are conducting, both pre- and post-surveys, will be anonymous. We will only be asking about their thoughts and knowledge on STEM, age/grade, any family in STEM jobs, etc.

APPROVED BY
WPI IRB #1
6/16/2022 - 5/11/2023

COVID Guidelines. We understand that COVID is still a large concern. In this focus-group study, we will all be masked and we will be following the Girls Inc. policies for COVID. We will follow the Symptom Tracker that Girls Inc. uses, and proceed with the necessary precautions.

Child Information

Full Name:_____ **Age:**_____ **Current Grade:**_____

Consent

TO WHOM IT MAY CONCERN:

Filling out all the below spaces does hereby give consent for our (my) child, _____, to attend and have the option to participate in the pre-survey, STEM activity(s), and post-survey as explained above. This study and activities will be sponsored by the **Worcester Polytechnic Institute** and **Girls Inc. of Worcester, MA** from **May 11, 2022** to **June 24, 2022**.

We (I) also give consent for pictures and videos to be taken while our (my) Girls Inc participant, _____, participates in these activities. Pictures and videos might be taken during the activity and the surveys. These pictures would be included in our presentation and final report, which will be posted on the digital.wpi.edu website and the wp.wpi.edu/wcpc website. The pictures and videos will be from angles such that the child's face will not be visible. The audio and, potentially, the visuals from the videos, would be used to further our research and data collection for our study. The pictures, audio, and videos will be securely stored in a password-protected Google Drive folder that only we will have access to.

I (We) consent for my Girls Inc. Participant's picture to be present in our research report:

☐ No ☐ Yes

I (We) consent for my Girls Inc. Participant's to participate in the following:

(*Check all that apply*)

☐ A pre-survey ☐ The STEM activity ☐ A post-survey

If your child does not wish to attend the above activity, Girls Inc. will provide them with alternative activities, during the time of our activity.

For any questions and concerns about the research please contact us at gr-GirlsInc-E22@wpi.edu

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☐ By checking this box and typing my name below, I am electronically signing this consent form.

Parent/Guardian Signature:_____

Relation to Student:_____ **Date:**_____

NOTICE:

In the event of an emergency, Girls Inc. will contact you with the emergency contact information you have provided them.

Questionnaire

1. **Does anyone in your *Girls Inc.* Participant's family work in any STEM (science, technology, engineering, math) jobs or working to get a STEM degree? If so, who?**

2. **Is your *Girls Inc.* Participant's getting exposure to STEM (science, technology, engineering, math) out of school? If so, what kind of exposure is she receiving? How is she receiving this exposure?**

3. **What does your Girls Inc. Participant wish to be when she grows up?**

D.2 Pre-Survey

Here's a survey to fill out! If you need help answering, ask a teacher or one of us!

1. **"What grade are you in?"**

2. **"Is there anyone in your family who works with science, math, or technology? If so, who?"**

3. **What's your favorite subject in school?**

4. **What're your top three favorite pieces of technology?**
   a.
   b.
   c.

5. **Do you enjoy Science?**
   Yes
   No

6. **What's your favorite thing to learn about in science?**

_____ Biology	_____ Chemistry	_____ Physics
_____ Animals	_____ Dinosaurs	_____ Ocean
_____ Human Body	_____ Weather	_____ Geology
_____ Space	_____ Measuring	_____ Plants

_____ Other, what is it?: _____
_____
_____
_____

7. **Do you enjoy Math?**
   Yes
   No

8. **What's your favorite part of math?**
   _____ Addition/Subtraction _____ Multiplication/Division
   _____ Fractions/Decimals _____ Counting _____ Algebra
   _____ Word Problems _____ Percents _____ Ratios
   _____ Equations/Inequalities _____ Graphing
   _____ Other, Please Specify: _____

9. **Do you enjoy building?**
   Yes
   No

10. **"What does STEM stand for?"**
    S_____ T_____ E_____ M_____

D.3 Post-Activity Survey

Activity Survey

1. **At the beginning, before starting the activity….**Introduce yourself. Tell them what you are studying and what you want to be when you grow up.

2. **At the beginning of the activity….**Go around each group ask for their name and what they want to be when they grow up. **Ask questions 3-5.**

3. STEM stands for science, technology, engineering, math. What does science mean to you? What do you think a scientist does?

4. What do you think an engineer does? Do you guys find that stuff interesting?

5. Do you guys find math interesting? If so, what do you like most about math?

6. **Near the end of the activity (20 minutes before the end of the hour)….** Ask if they found the activity fun (1= not at all, 5=very much so)
   1 2 3 4 5

7. What did you find to be the most fun?
   _____

8. Do you think there was enough time for the activity? (1= not enough time, 5= too much time)
   1 2 3 4 5

9. I understood the instructions for the activity. (1= not at all, 5=very much so)
   1 2 3 4 5

10. Activities like this are new to me.
    Y_____
    N_____

11. I have done activities like this in school (0= not at all, 5=very much so)
    Y_____
    N_____

12. I learned a lot in this activity. (0= not at all, 5=very much so)
    1 2 3 4 5

13. Do you guys have any questions about the activity?

_____

If the participants finish early, draw a scientist on a paper. We can either collect or take pictures of that drawing.

D.4 Pilot Study Data

Senses					
Grade	Fun	Instructions	New Activity	Similar to School	Learn
4	Yes bc challanges	Clear	Yes	NO	5
3	Yes bc eating	clear	Yes	No	5
3	Yes	Clear	No	No	Yes
3	Yes	Clear	No	Yes	Yes
3	Yes	Clear	Yes		Yes
3	Yes	Clear	Yes		Yes
3	average of 4/5	5	No	No	5
All teens 7 total	6/7	easy			5/7 Yes
Ice Cream					
Grade	Fun	Instructions	New Activity	Similar to School	Learn
	Eating candy		No	4	1

Appendix E: Deliverable

E.1 Activity Schedule

Activity Schedule								
Week	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 7**	**Week 8**
Theme	***Grow With Me***	***How It's Made***	***Be Strong***	***Be Smart***	***Be Bold***	***Wet & Wild***	***Watch Me Shine***	***Summer's Best***
Topic	*Plant-Life*	*Wildlife Habitats*	*Characteristics of Humans & Animals*	*Engineer Design Process*	*Misconceptions about Nature*	*Water & Properties*	*Sun & Sunlight*	*Joy of Summer &Teamwork*
Day 1	Exploring Plant Life Cycle Using Chia Seeds	Engineers in Nature. Build a Bird Nest	Animal Senses	Bottle Rockets	Invasives & Nature Identification	Boat out of Nature	Experimenting With Sunlight & Temperature Change To Cook Food (Solar Oven)	Repeat Favorite Team Activity
Day 2	Making Model Of Plant Adaptation	Build a Dam Like Nature's Engineers. the Beavers	The Natures Of Predators & Prey	Engineering Challenge: Zipline Challenge	Bug Hunt	Animal Catch	Making Sun Print Art with Nature	Experimenting & Analyzing The Reaction To Create Ice Cream
Extra Activity	Nature Walk Scavenger Hunt	Build A Beehive	The Senses (Human)	Creating A Wind-Propelled Car		Water Quality Testing and Filtration	Cloud Formation. Cloud in a Bottle	Applying Creativity To Build A Tower

E.2 Ice Cream Activity

EXPERIMENTING & ANALYZING THE REACTIONS TO CREATE ICE CREAM

Objective:

The objective of this activity is for the girls to explore temperatures and the different methods of temperature change. In this activity, the girls will explore the process of freezing, in which they will be creating ice cream inside of a bag. The girls will be using their knowledge of cooling and applying it to a daily-life experience, all the while improving their culinary skills.

Grades:

Grades K-6. Be more hands on with the groups of grades K-2.

STE Standards:

1.K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change that can be solved by developing or improving an object or tools.

1.K-2-ETS1-2. Generate multiple solutions to a design problem and make a drawing (plan) to represent one or more of the solutions.

3.3-5-ETS1-4(MA). Gather information using various informational resources on possible solutions to a design problem. Present different representations of a design solution.

Time:

This activity will take approximately 1 hour long.

Context:

Hello my store owners! It is I, the CEO! We, here at **Girls Inc. & Co. Ice Cream Parlor** are about to announce our newest product. But before we do so, we need to make the best ice cream we can. And today is the day we do this. Each one of you will be making and testing your own ice cream to get the best possible ice cream. **Good Luck & Enjoy!!!**

Materials:

For a group of 20 girls:

1. 5 cartons of 32 fl. oz. Half & Half
    a. Optional: 1 cartons of Lactose-Free Half & Half
2. 3 bags of 16 oz. Rock Salt
3. 2 Large bag of Ice
    a. Recommended to have 3
4. 1 bottle of 16 fl. oz. Vanilla Extract
5. 1 bag of 16 oz. Sugar
6. Water tight Ziploc Bags
    a. Minimum of 30 Small Bags
    b. Minimum of 30 Large bags
7. Minimum of 30 Spoons
8. Measuring Utensils
    a. 2 Cup-measurement spoon
    b. 2 Teaspoon-measurement spoon
    c. 2 Tablespoon-measurement spoon
9. Recommended 4-5 pairs of warm Gloves
10. Ice Cream Condiments:
    a. Melted marshmallows
    b. Strawberry sauce
    c. Chocolate fudge
    d. Melted Caramel
    e. etc.
11. Toppings:
    a. Gummies
    b. Sprinkles
    c. Skittles
    d. M&Ms
    e. Chocolate

Instructions:

Preparation:

1. Set up table full of materials/ingredients with caution of potential allergies:
    a. Small ziploc bags
    b. Half & Half & Cup-measuring spoon(s)
        i. Make sure the lactose free Half & Half are in the seperate location
    c. Vanilla Extract & Teaspoon-measuring spoon(s)
    d. Sugar & Tablespoon-measuring spoon(s)
    e. Big ziploc bags
    f. Cooler full of Ice
    g. Rock Salt & Cup-measuring spoon(s)
    h. Gloves
    i. All of the toppings and condiments with spoons
    j. Spoons for eating the ice cream

Activity:

1. Pick a volunteers to demonstrate the activity to the girls
2. Have a volunteers pick the material need for the ice cream
    a. Small ziploc bag
    b. 1 cup of Half & Half
        i. Pour it into the small ziploc bag
    c. Add 1 teaspoons of vanilla extract into the bag
    d. Add 1 tablespoon of sugar
        i. They can add one more tablespoon if they wish
3. Once all the materials are occurred, have her securely close the bag
4. Then grab the rest of the materials:
    a. Large ziploc-bag
    b. Ice
        i. Fill the bag half-way
    c. ¼ cup of rocksea salt
        i. Use cup-measurement spoon
        ii. Put the salt into the large ziploc bag
5. Place the small ziploc bag into the big ziploc bag
    a. Option to add more ice into the large bag
6. Securely close the large bag
7. Grab a pair of gloves and shake the large bag
    a. This is an optional step
    b. There are only 5 gloves to grab
8. Shake the bag for 6-10 minutes
    a. Add more ice if needed during those 10 minutes
9. At this point, have the girls line up and grab the materials as previously mentioned and repeat the sets.

10. Once done, take out the small bag
    a. Rince the bag with cold water
    b. Also rince the top of the bag (above the seal)
11. Once done, grab a spoon from the table
12. Open the small bag and mix the ice cream with the spoon
13. When satisfied, grab some condiments and topping from the table
14. **Enjoy!!!**

Reflection Questions:

1. How did everyone try to prevent salty ice cream?
    - The best way was to use two small bags (one over the other).
2. Why did we add salt to the large bag? What does the salt do?
    - The salt causes the ice to become colder and turn into slush, allowing the Half & Half mixture to turn into ice cream. The salt decreases the freezing point, or temperature, of the water to below 32°F, or below freezing. The reason we use salt rather than a freezer is so that we can achieve the "ice cream"-texture, rather than putting it in a freezer and just having an icey rough texture.
3. Why did we use rock salt versus regular salt?
    - The rock salt is more effective in cooling than regular salt.
4. Why did we shake the bags?
    - To evenly spread out the freezing ice as much as possible. This allows for the mixture to evenly freeze and turn into ice cream.
5. Why did we use gloves to shake the ice cream?
    - The salt makes the ice get colder, so it would be safer to wear gloves.

Apply For The Future:

- There are different ways to get to your goals, as we saw today with the ice cream
    - You can use one or two small zip-loc bags, or shake at different speeds or times, and ultimately come out with the same results
    - In everyday life, use this. You do not have to do things like everyone does. Just remember that when you do it differently, you will face a different set of problems. **Always hope for the best and prepare for the worst!**
- Now whenever you are feeling hungry or its hot and you need something cold and refreshing, you can use what you learned from this activity and recreate it making the best food
- **Maybe one day, you can create your own ice cream business from what you learned today!**

References:

https://www.thebestideasforkids.com/ice-cream-in-a-bag/

E.3 Human Senses Activity

Human Senses Activity

Objective:
To explore how their senses work and to realize that our senses are able to do different things and some change what our other senses are.

Grades: Grades K-6. Be more hands-on with the groups of grades K-2.

STE Standards:
1-LS1-1. Use evidence to explain that (a) different animals use their body parts and senses in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air, and (b) plants have roots, stems, leaves, flowers, and fruits that are used to take in water, air, and other nutrients, and produce food for the plant.

Time: 45 Min-1 Hour

Context:
You are training to be a physical therapist and to help people you'll need to understand the human body

Materials:
Per 20 kids
Sound

- 20 Film or pill bottle type of canisters
- Different things to fill up the containers, 2 of each thing per container
    - Examples:
    - Acorns
    - Sticks
    - Small Pebbles
    - Large Pebbles
    - Pine needles
    - Buttons
    - Pennies
    - Paperclips
    - Wood Chips
    - Bottle caps
    - Cork
    - Beads
    - Sea glass
    - Paper

- Dried pasta
- Dried beans

Heart rate

- 10 Stopwatch

Taste/Smell

- 200 skittles, 40 of each color
- 20 Cupcake paper cups
- 1 Hand sanitizer bottle

Instructions:

Sound

Preparations

1. In 2 containers put 2 of the same thing. 2 of the same thing will cause a sound when the container is shaken. Prepare enough so that each kid has their own container. This is to randomly assign the kids into groups of 2 for the next activity.

Step-by-step

1. Introduce the topic to the girls by asking them some questions.
    a. Does anyone know about our senses?
        i. What are they?
    b. Do you think you will be able to identify things just from the noise they make?
2. Give each kid a random canister or have a table with all of them and have each kid take one.
3. Get the kids to shake the canisters and try to find someone with the same sound as theirs and then guess what is inside.
4. They open their container and see if their guess was correct and if both of them have the same thing in their container.
5. If they have different things in their container, have them go and find the person with the same thing, to keep it fair. These teams will be for the next activity

Heart Rate

Preparations

1. Make sure that you have enough stopwatches so that there are enough for half the number of kids

Introduction questions

1.

Step-by-step

1. Introduce the topic to the girls by asking them some questions.
    a. What are we able to do with our sense of touch?
    b. What would we not be able to do?
    c. What senses can we use to measure our heart rate?
        i. Sound using a stethoscope and touch using our fingers.
    d. Where can we feel our heart rate?
        i. See images below.
2. Show the kids where they can feel their heart rate, on their wrist and their neck but their neck is easier. Explain to them that it is where their veins are close to the surface and the vein in your neck is larger so it's easier to feel the pulse. The diagram below shows locations.
    a. Walk around and see if the kids need help finding their pulse.
3. Explain to the kids that to work out their heart rate they need to find their heart rate in beats per minute so they will count the number of beats they feel in 10 seconds and then multiply by 6.
4. Have one kid in the group keep track of the time and the other count the number of pulses they feel in 10 seconds and record it on paper. Have each kid find their own heart rate.
5. Multiply the number of pulses they have in 10 seconds by 6 to get beats per minute for their resting heart rate.
6. Have the kids run around for a few minutes to get their heart rate up.
7. Repeat steps 3 and 4 again to find their active heart rate but don't tell them their heart rate will increase.
8. Walk around and ask the kids that finished what the difference in their heart rate was from before and after. Also, why did it change? Having the kids come up with their own conclusion would be the best.

Taste/Smell

Preparations

1. In the cupcake, paper cups put one of each skittle in it so you don't have to do this during the activity. Prepare this for double the number of kids.

Step-by-step

1. Introduce the topic to the girls by asking them some questions.

   a. How good is everyone's taste?
   b. What affects what we taste?
      i. Other things we taste and things we smell.
   c. Have any of you smelt something bad while eating and it affects what you taste?
2. Have each camper use hand sanitizer before beginning
3. Give each kid 1 of each flavor of skittle and tell them not to eat them yet until they finish explaining the instructions.
4. In their duo groups, one kid closes their eyes and the other kid gives them a random color skittle for them to guess what flavor it is and record if they got the guess correct or wrong.
5. Repeat step 2 with all the skittles so the kids have a number for how many skittles they got the flavor correct. Then repeat so that each kid has the chance to guess the skittle taste.
6. Repeat steps 1 to 3 but now the kids will pinch their nose and close their eyes while they eat the skittle. The emphasis is that they have to cover their nose the entire time they are eating.
7. The kids should notice it is harder to tell the skittles apart than before and ask them why that might happen.
8. The kids should come to the conclusion that a lot of their taste comes from the smell.

Reflection Questions:

Sound

1. What material do you think is in your container from the sound? Why?

Based on the material, what could it be?

Heart Rate

1. Why do you think you can feel your pulse?
   a. Probe: What do you think you are feeling with the pulse?
   b. Answer: blood being pumped by the heart
2. What was the difference in your heart rate before and after you exercised? Why?
   a. Answer: It increased because blood carries oxygen to your muscles and when exercising your muscles need more oxygen so your heart beats faster.

Taste/Smell

1. Was there any difference when you held your nose?
2. Why do you think you got less correct the second time you did it? What changed?

a. Answer: They covered their nose

3. What does this show you?
    a. Answer: Actually, all Skittles are the same flavor, which is a generic "fruit" taste. We think it has different tests because our brains associate their colors with certain tastes, and their scent is different. So when you bite that yellow Skittle, your brain sees the color, smells the smell, and you believe you're eating a lemon flavor.

Applied in the future

Being able to know how to find someone's heart rate is very useful in emergency situations. People's heart rate shows how well that person is feeling and a weak or no heart rate is bad.

Heart Beat Locations Diagrams: