Empowering the Bucarabones Community Through STEAM Curriculum

An Interactive Qualifying Project submitted to the faculty of WORCESTER POLYTECHNIC INSTITUTE in partial fulfillment of the requirements for the Degree of Bachelor of Science

Sponsor: Centro de Apoyo Mutuo de Bucarabones Unido (CAMBU), Puerto Rico

Submitted to CAMBU and Worcester Polytechnic Institute:

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Date: February 28, 2024

This report represents the work of WPI undergraduate students submitted to the faculty as evidence of completion of a degree requirement. WPI routinely publishes these reports on its website without editorial or peer review.

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Abstract

This project explores the challenges in rural Puerto Rico due to school closures, limited investments in teachers and standardized teaching methods. Centro de Apoyo Mutuo Bucarabones Unido (CAMBU) is a community-center working to bridge educational gaps in Bucarabones Puerto Rico. CAMBU has developed programs to support the Bucarabones community and their needs. CAMBU currently holds basic technology and art after-school programs for their community members. Our project developed a STEAM-based curriculum for youth and adults at the CAMBU community center.

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Empowering the Bucarabones Community Through STEAM Curriculum

FIGURE A: A FRONT VIEW OF THE CENTRO DE APOYO MUTUO BUCARABONES UNIDO (CAMBU) COMMUNITY CENTER

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Introduction

Since 2007, Puerto Rico's Department of Education has closed 673 schools, nearly half of the public schools in Puerto Rico (Abizeid, 2020). Schools are used by their communities as educational, health, childcare, after-school, and recreation facilities. Public schools also serve as a "third place" where people come together to build relationships and supportive networks (Rosenbaum et al., 2021). When a school is closed, a vital resource is taken away from the community. School closures lead to student enrollment decline, a drop in academic performance, and longer commute times (Rivera Rivera, 2022; Rodríguez, 2015; Yedidia et al., 2020). Puerto Rican communities have taken initiative to tackle the school closure epidemic through the rescued school movement, creating community centers and resilience hubs, building a strong sense of community, and providing access to basic resources and information (Qin, 2020).

Centro de Apoyo Mutuo Bucarabones Unido (CAMBU) is one such community center, born of the rescued school movement. Located in southwestern quadrant of Puerto Rico, CAMBU is in the rural town of Bucarabones, with a population of 115 and an average yearly income of $20,133 (*Bucarabones Barrio, Maricao Municipio, Puerto Rico - Census Bureau Profile*, 2020). CAMBU has transformed one of the community's abandoned schools into an educational, cultural, and recreational development center.

Background

Due to the lack of STEAM-based opportunities in the public education system for under-represented groups — including Hispanics, African Americans, and women — students feel they will not excel in STEAM programs (President's Council of Advisors on Science and Technology [PCAST], 2010). Furthermore, the Puerto Rican education system faces notable challenges and disparities, specifically in STEAM (Science, Technology, Engineering, Arts, and Mathematics) education.

Given that the education system in Puerto Rico is characterized by a standardized curriculum, teachers receive incentives for higher test scores and attendance (Rosa, 2021). Pressure to "teach to the test" has hindered teachers' motivation to incorporate qualitative interdisciplinary approaches (Jürges et al., 2005). Rosa (2021) argues such incentives motivate teachers to favor topics that will lead to high test scores rather than increase individual students' interests.

FIGURE B: STUDENTS ENGAGING IN AN AFTER-SCHOOL PROGRAM AT CAMBU

Outside the formal education system, community centers such as CAMBU step up to fill the gap. Through after-school programs, the adaptive education model associated with STEAM addresses the pitfalls found with the traditional education system, acknowledging the needs and experiences of individuals (Bell et al., 2009). Using project-based learning (PBL), a common approach in STEAM programs, is shown to promote greater levels of critical thinking, creativity, and engagement. Some after-school programs that supplement K-12 STEAM education are Destination Imagination and Studio STEM. These programs utilize Discover, Define, Model, and Transfer (DDMT) to develop students' curiosity, creativity, communication, and critical thinking (Wang, 2019).

Project Objectives

The goal of this project was to empower the Bucarabones community by building STEAM-based programs to broaden opportunities for the youth and adults in the community. Our research was comprised of two main objectives:

1. **Identify educational interests of the adult and youth population at CAMBU.**
2. **Develop and pilot lesson plans for beginner topics that can be implemented and adapted based on students' needs.**

Methods

We conducted interviews and observational studies to determine teaching methods and educational interests for CAMBU programs. During these observations and interviews we covered topics such as STEAM-based interests, pedagogical experiences, teaching experiences, and the successes and areas of growth for CAMBU.

The project then shifted towards developing beginner lesson plans. The previous insights from CAMBU members and professionals informed our topics of choice and teaching methods. We also referenced programs such as Destination Imagination and Studio STEM.

We then conducted pilot lessons at CAMBU with Ms. Fuentes's support. We chose to pilot a google sheets-based lesson for the adult classes and a physics-based lesson for the children's class. During the pilots, the group observed classroom behaviors and conducted post-lesson interviews to identify strengths, weaknesses, and areas for improvement. The lesson plans were then adjusted based on the observed results of the pilot.

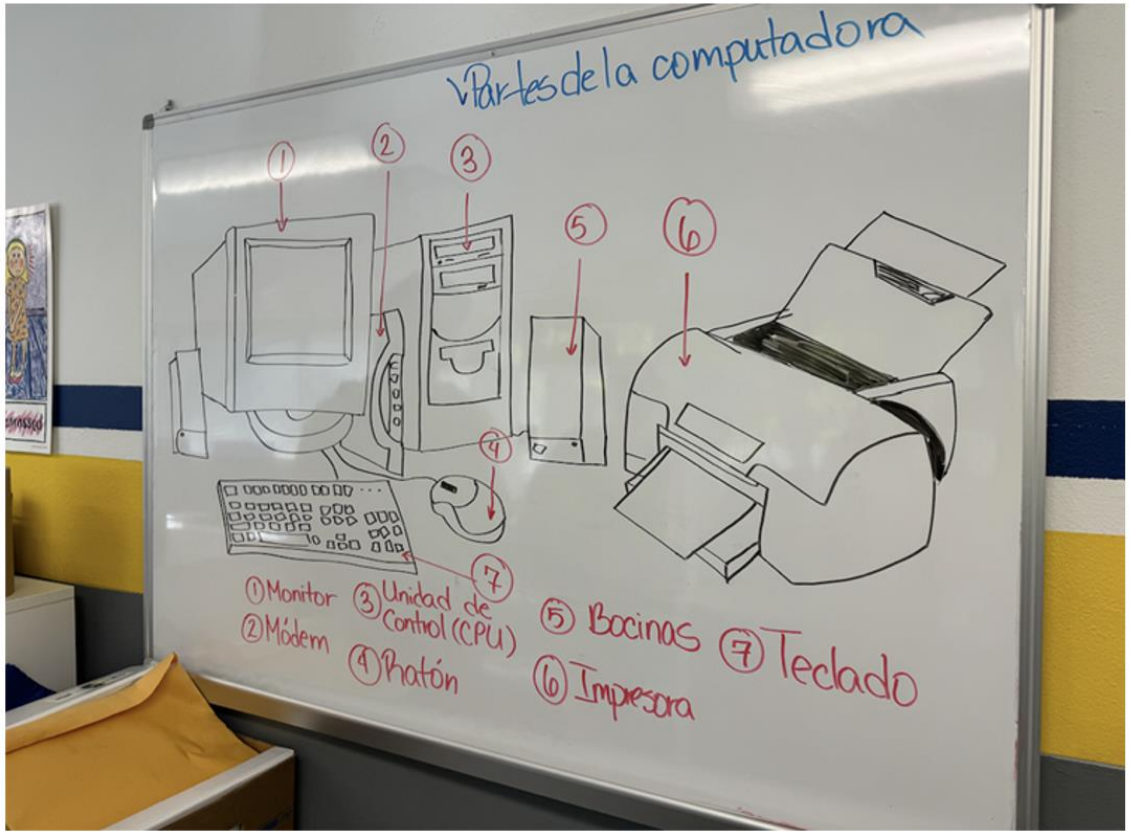

FIGURE C: A WHITEBOARD USED TO TEACH AT A COMPUTER STRUCTURE CLASS AT THE BOYS AND GIRLS CLUB

Findings

Through our interviews and observations of after-school programs, we noted the significance of hands-on learning. This hands-on learning approach ensures long-term engagement and enhances material retention, addressing the shortcomings of standardized teaching methods prevalent in public schools.

To determine engaging STEAM topics to implement into CAMBU, we used the information from interviews with CAMBU students and educational program professionals and considered CAMBU's budget of approximately 500 dollars per month and the materials available.

Based on these observations and interviews we created 21 lesson plans based on the following topics:

- Basic Coding (Scratch)
- Basic Coding (Java)
- Architecture
- Physics
- Chemistry
- Biology
- Google Sheets
- Research using Google Search
- Basic AI Literacy

FIGURE D: TEACHER DEMOING INTERACTIVE PORTION OF LESSON AT CAMBU

Lesson plans were developed with learning outcomes and structured to progress from beginner to advanced levels. The "I do, we do, you do" format was adopted to facilitate hands-on learning, incorporating group activities and independent work to reinforce the learning outcomes.

Following the development of lesson plans, we conducted pilot programs to assess their effectiveness. The feedback from both adult and youth classes highlighted the need for improvements in flow and clarity, particularly in transitions between the lecture and activity. We adjusted based on observations and student feedback, including the addition of key terms at the beginning of lessons, multiple additional activities for faster-paced classes, and slide decks for visual representation during lectures.

Additional learning resources were provided to enhance instructors' understanding of the lessons and improve retention among students. Detailed explanations and graphics incorporated into the lessons allowed for an easier grasp of the concept by the student. The adjusted lesson plans were reviewed by the main CAMBU instructor, Ms. Fuentes, to ensure clarity and effectiveness in achieving learning objectives.

FIGURE E: STUDENTS PARTICIPATING IN PHYSICS ACTIVITY

FIGURE F: TEACHER GIVING INTRODUCTORY LECTURE FOR GOOGLE SHEETS LESSON

Conclusion

Our project aimed to empower the Bucarabones community by building STEAM based programs to broaden opportunities for the youth and adults. Through our interviews and observations, we created a set framework of engaging STEAM-based curriculum that empowers CAMBU students amid the public education learning gap.

The goal of our lesson plans was to provide CAMBU with the material and resources to teach weekly STEAM-based programs to students. We designed the lesson plans to be low-budget, easily understandable and applicable to the students' daily lives. To empower students for future opportunities, these lesson plans will encourage students to broaden their view of possibilities.

The collection offers a year's worth of lesson plans and is the first step in opening doors for CAMBU's growth. The anticipated growth includes higher student attendance, engagement, and interest in STEAM-based careers. Through our project, we believe the developed curriculum supplements the empowerment of future CAMBU students in the face of socioeconomic challenges.

Introduction

Begin by showing the students the Plants Native to Puerto Rico. Discuss with them the plants that grow in Bucarabones. Ask students, "Think about what plants grow around the Bucarabones community. Do you know any of their names? What do they look like?" Then go into the follow up questions.

Plants Native to Puerto Rico:

Seagrap Stiff *Bristle Fern* *Golden Pathos*

Follow-up Questions:

1. "What are some similarities you can identify in all these plants?"
2. "Does anyone know how plants gain their energy?"

After giving them time to brainstorm, let them know that this activity will involve looking into how plants utilize chlorophyll to grow.

FIGURE G: EXAMPLE OF THE INTRODUCTION PORTION OF A LESSON PLAN

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Acknowledgements

We extend our heartfelt gratitude to our two advisors, John-Michael Davis and Melissa Belz, whose unwavering support and guidance were instrumental in navigating the complexities of our IQP in Puerto Rico. Their expertise, dedication, and encouragement propelled us forward, enabling us to overcome challenges and achieve milestones.

Furthermore, we express our deepest appreciation to our generous sponsors, Omar Reyes, Lourdes Hernandez, and Isa Fuentes. Your belief in our project and commitment to its success have been pivotal. Your support not only provided us with the resources needed but also served as a motivating force, pushing us to strive for excellence.

The collaborative efforts of our advisors and sponsors have left an indelible mark on our project, shaping it into an impactful term. We are grateful for the knowledge, insights, and opportunities they shared, enriching our learning experience, and contributing significantly to the project's success. Their unwavering support has been a source of inspiration, and we are fortunate to have had them by our side throughout this journey.

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1: Introduction

Since 2007, Puerto Rico's Department of Education has closed 673 schools, nearly half of the public schools in Puerto Rico (Abizeid, 2020). When a school is closed due to a lack of government support, a vital resource is taken away from the community. Schools are used by their communities as educational, health, childcare, after-school, and recreation facilities. Public schools also serve as a "third place" where people come together to build relationships and supportive networks (Rosenbaum et al., 2021). Furthermore, school closures lead to longer commute times, student enrollment decline, and a drop in academic performance (Rivera Rivera, 2022; Rodríguez, 2015; Yedidia et al., 2020). However, Puerto Rican communities have taken the initiative to tackle the school closure epidemic through the rescued school movement. Rescued school projects create community centers or resilience hubs that build a strong sense of community and provide access to basic resources and information (Qin, 2020).

Organizations that are part of the rescued school movement are also confronted with challenges such as securing government approval, navigating policies and regulations, and ensuring compliance with guidelines for repurposing public structures (Dowdall & Warner, 2013). Additionally, addressing repairs and renovations necessary to transform the buildings into functional spaces demands resources, funding, and volunteers. Centers must address these challenges through thoughtful consideration and active community engagement to ensure inclusivity and effectiveness in meeting local needs (Arnon et al., 2023).

An organization that is part of the rescued school movement is Centro de Apoyo Mutuo Bucarabones Unido (CAMBU) in the rural town of Bucarabones, located in the southwestern quadrant of Puerto Rico. Bucarabones has a population of 115 people with an average yearly income of $20,133 (*Bucarabones Barrio, Maricao Municipio, Puerto Rico - Census Bureau Profile*, 2020). CAMBU has transformed one of the community's abandoned schools into an educational, cultural, and recreational development center.

The goal of this project was to empower the Bucarabones community by building STEAM based programs to broaden opportunities for the youth and adults in the community. With this goal in mind, our research was comprised of two main objectives:

1. Identify educational interests that would be of value to the adult and youth population.
2. Develop and pilot lesson plans for beginner topics that can be implemented and adapted based on students' needs.

This paper begins with a discussion of the Puerto Rican public education system, touching on the closing of schools, the importance and benefits of STEAM education, and the role of our sponsor, CAMBU. We then explain the multi-method approach that guided our project. We determined that hands-on, STEAM-based after-school programs supplement the lack of student empowerment in the public education system. We developed STEAM-based lesson plans for CAMBU based on our findings.

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2: Background

2.1: The Puerto Rican Public Education System

The Puerto Rican education system bases its curriculum on the United States national standard. The standard curriculum includes units and topics followed by teachers to prepare students for standardized testing, which reflects an evaluation of both the student's understanding of the material and the teachers' abilities (Salinas & Guajardo, 2022). The Puerto Rican education system incentivizes doing well on standardized curriculums; these incentives include but are not limited to a $1,500 bonus for teachers who hit benchmarks on test scores and student attendance (Rosa, 2021). Rosa argues such incentives motivate teachers to favor topics that will lead to high test scores rather than individual students' interests. Alongside the standardized approach teachers are incentivized to use, they are also considered a part of the undervalued workforce. With the median teacher salary in Puerto Rico being around $29,000, almost half of a teacher’s salary on the mainland, there is a shortage of teachers (Lake, 2019). Teachers also must adapt to shifting subjects and grade levels due to decreasing student enrollment from emigration (Davis et al., 2023).

These difficulties have hindered teachers' motivation to incorporate qualitative interdisciplinary approaches (Jürges et al., 2005). The standardized approach poses challenges for students in Puerto Rico. As seen in Figure 1, less than 50% of students are proficient or better in the subjects tested (DE: Puerto Rico Department of Education, 2017). Standardization and teacher demotivation in individualized approaches are not the only challenges students face when going to public school. Public school closures have risen throughout Puerto Rico for a multitude of reasons, including the government implementing austerity measures, lack of funding, and emigration, limiting students' access to public education.

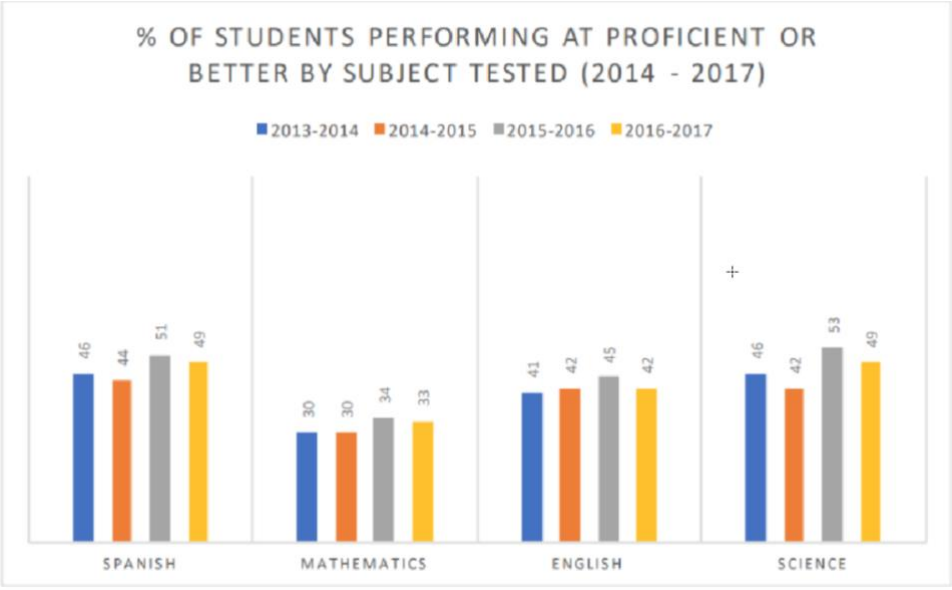

Figure 1: Percentages of students performing at proficient or better by standardized subject testing from 2013-2017 (DE: Puerto Rico Department of Education, 2017)

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2.1.1: Puerto Rican School Closures

Prior to Hurricane Maria, Puerto Rico was marked by substantial debt which led the government to declare bankruptcy. Puerto Rico's debt became amplified following Hurricane Maria, after which the island's K-12 schools suffered over $142 million in damages (Brusi, 2022). In response to the worsening debt, the government implemented austerity measures which included significant cuts to the education system (Brusi, 2020). These measures included reduced government intervention, faculty layoffs, smaller budgets for school materials, and school closures (Brusi, 2022). The government prefers to close schools that already have challenges including lack of faculty, students, or funds (Basu, 2007). The cut of government educational funds imposed more challenges on already underfunded schools (Aja et al., 2018).

The dire situation in the school system was further intensified by Hurricane Maria. As seen in Figure 2, Maria led to an estimated 23,000 - 43,000 school-age children to leave Puerto Rico, dropping the school population (Figueroa-Lazu, 2021; Hinojosa et al., 2019). When a school has a decreasing number of students, the Puerto Rican government has more incentive to shut it down. With an increase in school closures and the absence of sufficient government aid, Puerto Rican communities depended on the efforts of their members to recover and rebuild.

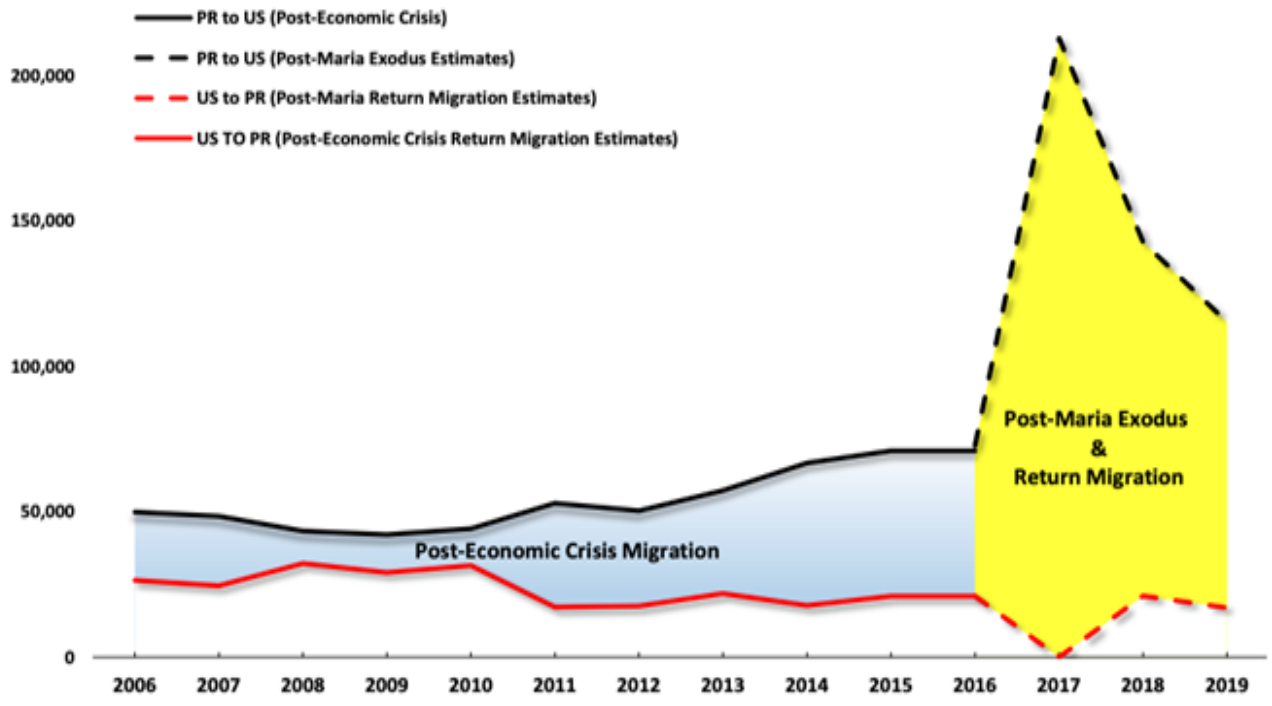

Figure 2: Migration patterns of Puerto Rico by year (Figueroa-Lazu, 2021)

2.1.2: Revitalized School Buildings

Given the lack of government support and available spaces, organizations developed community centers and resilience hubs in closed schools. Such resilience hubs provide access to basic needs and serve as a social center, allowing residents to stay informed and connected (Qin,

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2020). The rescued school initiatives foster a strong sense of community and provide vital access to resources and information. With organizations willing to develop these centers, a door opens to include more individual and project-based learning by incorporating STEAM into their programs.

2.2: STEAM Education in Puerto Rico

STEAM is an educational approach designed to cultivate critical thinking in young students through interdisciplinary approaches to challenges (Daugherty, 2013). STEAM programs foster well-rounded individuals with the ability to apply knowledge in real-world contexts. While STEAM programs have gained prominence, there is still an under-representation of Puerto Rican students (Snyder et al., 2019).

Due to the lack of STEAM-based opportunities in the public education system for under-represented groups — including Hispanics, African Americans, and women — students feel they will not excel in STEAM programs (President's Council of Advisors on Science and Technology [PCAST], 2010). Under-represented groups of students are exposed to more inequalities in the educational system because of low school funding, lack of instructional resources, and standardization.

To teach the open-ended research of STEAM, many curricula rely on project-based learning (PBL). Through PBL, students create their hypotheses, perform unique tests, and derive individual solutions. PBL has also been shown to promote greater levels of critical thinking, cognitive demands, and positive perceptions of STEAM topics (Diego-Mantecon et al., 2021; Herro & Quigley, 2017; Yaki, 2022). PBL further allows for higher student engagement than traditional pedagogical approaches (Chistyakov et al., 2023). We based our definition of a STEAM curriculum on the PBL adaptive education model. The model focuses on empowering students through science, technology, engineering, arts, and math.

Through after-school programs, the adaptive education model of STEAM addresses the pitfalls found with the traditional education system, acknowledging the needs and experiences of individuals (Bell et al., 2009). Removing standardization allows teachers to focus on what matters: the student themselves. Specifically, after-school STEAM programs are shown to boost curiosity, encourage creativity, improve social skills, and critical thinking skills — all beneficial in real world applications (Bell et al., 2009). Some after-school programs that supplement K-12 STEAM education are Destination Imagination and Studio STEM. These programs utilize Discover, Define, Model, and Transfer (DDMT) to develop students' curiosity, creativity, communication, and critical thinking (Wang, 2019). In Destination Imagination, middle school students in an after-school program work together to solve STEAM based challenges, catered to exploring the students' passions and learning new skills. Similarly, in Studio STEM, middle school students experience engineering design challenges (Evans et al., 2016). The use of the core ideas of the science inquiry engages students' critical thinking and creativity; as seen in Figure 3, this illustrates the engineering design method (Allen et al., 2014; Lee et al., 2023). The

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five main learning outcomes of STEAM programs are curiosity, creativity, communication, critical thinking, and real-world application.

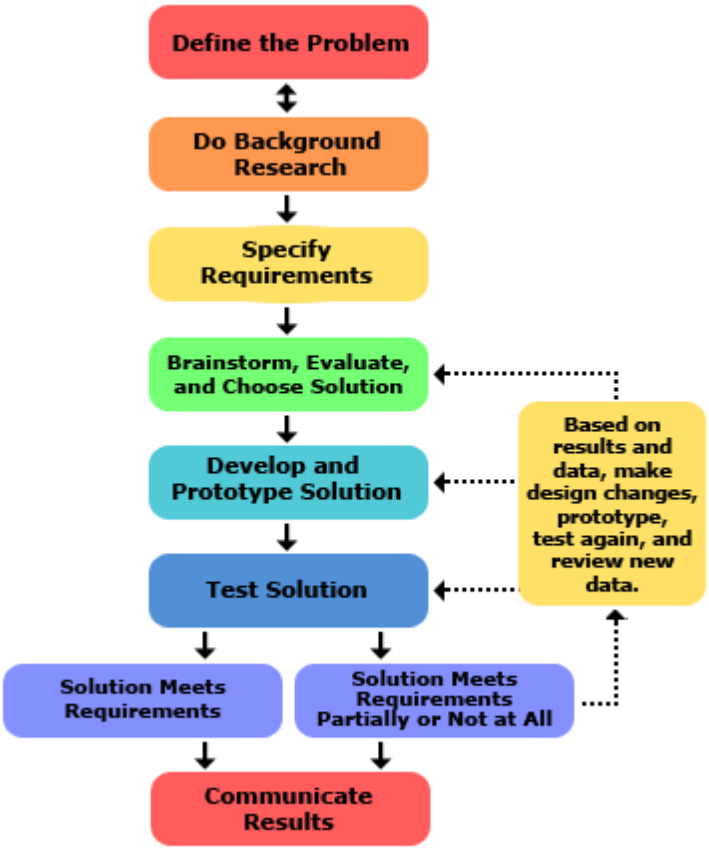

Figure 3: Diagram Outlining the Engineering Design Method

2.2.1: Curiosity

From the inherent nature of project-based learning (PBL), teachers enable students' curiosity through classroom design and teacher investment in students. By developing a personal connection with each student, open communication, and creating a safe classroom environment STEAM based PBL programs promote a mindset of growth — putting students learning first (Gullapyan, 2020). Encouraging students to be inquisitive about the range of topics taught promotes deeper questions. In addition, with an emphasis of hands-on learning and implementation of DDMT, students see the direct effects of their work on a project. When STEAM topics are presented in a hands-on way, students who struggle with the subject matter are more engaged (Roberts et al., 2018). This interest in STEAM for students who traditionally struggle is especially important for empowerment. For example, first-hand interviews of students completing the Studio STEM program associated the completion of the project with terms such as "enjoy", "glad," and "accomplishment". Furthermore, as seen in Figure 4, Studio STEM participants reported significantly higher college plans, and science interests than their peers

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(Evans et al., 2016). Moreover, by supplementing K-12 schooling with STEAM programming, students experience increased motivation and curiosity, halting the decline of students' self-efficacy in STEAM (Chittum et al., 2017).

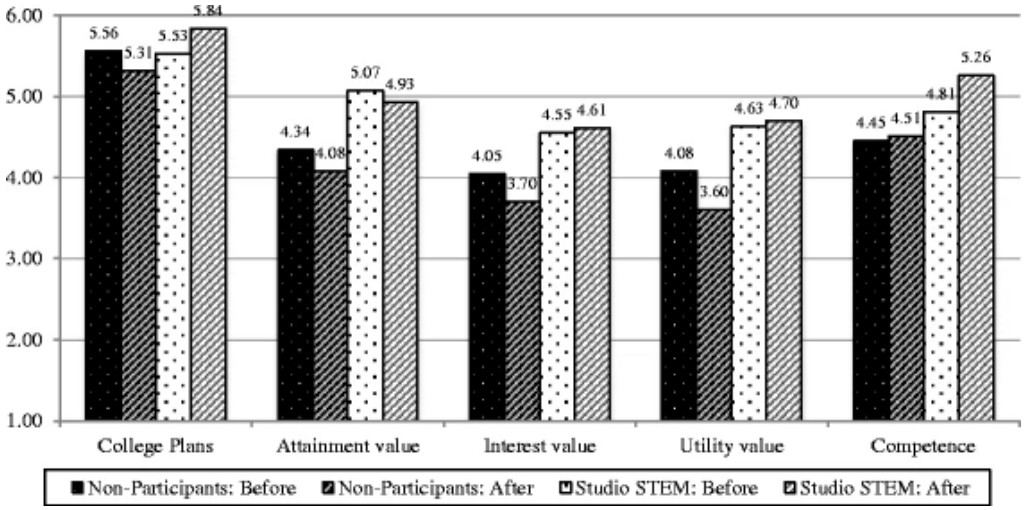

Figure 4: Means comparison between Studio STEM participants and the non-participants before and after program participation. Studio STEM participants n = 19; non-participants n = 102

2.2.2: Creativity

From the interactive nature of STEAM programs, students foster creativity by developing unique solutions versus a set solution. The STEAM curriculum achieves this development through an empowerment model, allowing students to explore many approaches to a problem from various viewpoints. Teachers empower students with control and autonomy, allowing them the freedom to make meaningful decisions throughout the project (Bell et al., 2009). For example, in the Studio STEM program, students make decisions such as what material to use and which groups they are in. This encourages students to change and guide their learning, a stark difference from traditional linear learning (Denson et al., 2015). Working in an environment where ideas are encouraged, students feel empowered to think outside the box, relating unrelated ideas together. This interdisciplinary approach to learning makes students experience "new ways to understand and see things" and "different ways to apply" concepts (Roberts et al., 2018).

Interactive after-school STEAM programs have the benefit of not being regulated by a national teaching standard. Therefore, teachers are more motivated to empower students' thinking which allows for more confidence and exploration in the classroom (Broom, 2015). It also increases the student's motivation in STEAM, making their learning experience more fun (Denson et al., 2015). Empowered students are more likely to have a growth mindset, learning through mistakes and failures. Developing a growth mindset sets the foundation for students to be lifelong learners, always wanting to improve and take risks. Students who are empowered to be creative and use a growth mindset also re-frame social comparison from negative to positive to optimize information processing (Hopkins et al., 2023).

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2.2.3: Social Skills and Teamwork

From growth mindset to creative empowerment, both directly translate into the collaborative landscape in STEAM programs. These programs use team-based activities to develop a growth mindset, social skills, and collaboration (Diego-Mantecon et al., 2021; Herro & Quigley, 2017; Yaki, 2022). STEAM programs encourage a culture of diverse ideas and making mistakes as a part of the learning journey (Bertrand & Namukasa, 2020). This collaboration fosters a supportive environment that encourages new ideas and perspectives. Instead of a competitive approach, students are taught to work in teams towards a common goal. As a result, they learn a fundamental aspect of leadership: valuing the growth of your team (Goggins, 2018; Willink, 2015).

As students approach group work through holistic collaborative methods, they can be more expressive and socially adaptable. Holistic approaches also help improve students' emotional intelligence and social skills; this improvement allows students to work with various personality types and cultural backgrounds tactfully, contributing to a rich and inclusive collaborative experience (Bell et al., 2009). In exploring the multifaceted benefits of STEAM education, informal mentoring also emerges as a significant theme. Beyond structured guidance from teachers and facilitators, an analysis of the Mathematics, Engineering, Science Achievement (MESA) program in California showed an unexpected increase in mentoring between students. The study states that the informal learning environment increased students' desire for their peers to succeed (Denson et al, 2015).

2.2.4: Critical Thinking

Teachers have used STEAM initiatives to grow their students' critical thinking and reasoning skills (Allard, 2023). Within the realm of STEAM, fostering curiosity and collaboration not only kindles interest but also plays a fundamental role in honing analytical thinking, problem-solving skills, and a deeper comprehension of intricate concepts. However, the structure and implementation of lesson plans also have a significant impact on the development of students' critical thinking abilities (Yaki, 2022). Teachers can prompt students by using methods such as DDMT to promote analytical thinking in STEAM based programs.

Two studies that implemented DDMT or similar methods found a correlation between STEAM-based learning and critical thinking ability in students. The first study followed a project studying the effect of a chemistry-based STEAM program and found that students were able to stimulate their creative and critical thinking through active self-reflection and questioning. The students followed the problem at hand doing relevant research, creating individual and group analyses based on information gathered, and identifying other interpretations of collected data (Rahmawati et al., 2019). Another study found that students who went through the Destination Imagination program tended to continuously ask questions and practice critical thinking throughout their entire project (Ward et al., 2023). The same study following Destination Imagination found that meaningful real-world activities cultivated improved performance that helped make students stand out compared to their peers.

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2.2.5: Real-World Application

Active engagement in practical experiences and real-world projects significantly improves students' preparedness for the workforce, equipping them with superior skills. This newfound capability not only enhances their immediate employability but also positions them to excel in their future careers (Ward et al., 2023). The study underscores the pivotal role of meaningful real-world activities in cultivating improved performance, enabling students to distinguish themselves from their peers.

Moreover, the acquisition of STEAM skills has been correlated with potential earnings increase of up to 6% compared to peers (Cohodes et al., 2022). Even in the absence of pursuing a directly related STEAM field, students can apply the hard and soft skills acquired to enhance various aspects of their daily lives. Notably, skills such as clear communication of ideas, project management, effective research, and analytical thinking have been identified as top-priority skills in the job market for 2023 (Dewar, 2023).

By adopting a pedagogical approach that incorporates tangible real-world examples, educational programs empower students to enter the workforce more adeptly compared to their counterparts. This underscores the significance of afterschool initiatives like Destination Imagination and Studio STEM, which serve as essential components in preparing students for the challenges of the real world.

High-quality after-school programs have positive effects on underprivileged students and focus on the needs of individual students as they mature (Kremer et al., 2015). Students from low-income households who participated in after-school programs had more positive work habits, more determination while completing tasks, and performed better academically. They also had better social awareness and skills compared to low-income students who did not participate in after-school programs (Reisner, 2007). Focus on curiosity, creativity, communication, and critical thinking in STEAM-based programs strengthens students' real-world problem-solving skills.

2.3: CAMBU

CAMBU, Centro de Apoyo Mutuo Bucarabones Unido, is a community based non-profit organization based in the rural community Bucarabones, Puerto Rico. CAMBU is a part of the rescued school movement, promoting the cultivation of educational, recreational, and cultural experiences for the empowerment of community members. Following Hurricane Maria in 2017, the community came together to create a centralized space that focuses on serving community members. Since then, the multipurpose community space has been utilized as an environment that combats the lack of educational opportunities and basic resources in Bucarabones. CAMBU is working to combine their current extracurricular programs with STEAM learning objectives and goals to better support their community. They have asked us to develop lesson plans and unit objectives. With space for growth, CAMBU's vision is to continue to develop programs to better support future generations in the face of socioeconomic challenges.

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3: Methods

The goal of this project was to empower the Bucarabones community by building STEAM based programs to broaden opportunities for the youth and adults in the community. With this goal in mind, our research was comprised of two main objectives:

1. Identify educational interests that would be of value to the adults and youth population.
2. Develop and pilot lesson plans for beginner topics that can be implemented and adapted based on students' needs.

To accomplish the objectives, we interviewed CAMBU members and educational program professionals to identify educational interests and learning gaps in the current curriculum. We identified reliable lesson frameworks for CAMBU programs. We then developed and piloted these lesson plans for CAMBU.

3.1 Objective 1: Identify Educational Interests and Learning Gaps

We identified the educational interests of youth and adults in Bucarabones through a series of interviews and observations. To determine an effective way to implement new programs at CAMBU, we interviewed CAMBU staff, volunteers, parents, and students as well as public-school teachers (Appendix A-D). We decided on semi-structured interviews due to their flexible structure, creating more opportunity for a natural conversation with the interviewee. These interviews gave a deeper insight into the first-hand situations that students faced in the Puerto Rican public education system.

3.1.1: Observe and Conduct Interviews with Educational Program Professionals

We emailed program professionals, including two after-school program coordinators and four public-school teachers, to set up semi-structured interviews and after-school program observations. We used web searches to find the emails of potential program professionals, asking to set up an interview while giving an overview of our project. We conducted four interviews in-person and two via Zoom. Before each interview, we researched the interviewee's background and area of expertise to cater specific questions during the interview. The topics discussed included students' engagement in educational topics and in different learning styles (Appendix C & D).

While conducting semi-structured interviews with the program professionals, one group member asked questions, and the other three group members listened and noted important information and quotes, as well as audio recorded the interview. The notetakers would also ask follow-up questions as needed.

While observing an after-school program in Bayamón Puerto Rico, one group member was designated to take pictures, while the other three group members took notes on the classroom climate. The class we observed was an introduction to technology class and took an hour. We used an observation sheet to note any important observations we noticed such as how long the lecture took, how long the students had to complete the activity and how attentive the

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students seemed. We refrained from disturbing the lesson and kept our distance to allow the class to run as normally as possible.

3.1.2: Observe and Conduct Interviews with CAMBU Members

To observe and conduct interviews with CAMBU members, we made two field visits to CAMBU. In our first visit, we observed two classes and noted the students' and teachers' engagement, participation, and understanding of the lesson. After observing the classes, we conducted interviews with four adult students, two youth students, one parent, and two volunteers. The topics discussed with the students included personal interests in STEAM, experiences with STEAM-based learning, and opinions regarding what CAMBU could offer to the Bucarabones community (Appendix A). We also interviewed one youth student's parent, gaining insight on the students' education and the benefits of CAMBU's programs (Appendix A & B). The topics discussed with the volunteers' included opinions about CAMBU and their current programs (Appendix B).

Due to some interviewees solely speaking Spanish, Ms. Isa Fuentes, one of our sponsors and CAMBU teacher, interpreted the questions and answers from the interviewees. We audio recorded each interview. One team member facilitated the interaction between Ms. Fuentes and the interviewee. The team asked follow-up questions and noted any important information or quotes. If participants were under the age of 18, a parent or guardian was present to provide consent and comfort during the interviews.

3.1.3: Analysis of Interviews

We performed thematic analysis, a coding process outlined by the Academy of Human Resource Development, because of its theoretical flexibility (Boyatzis, 1998; Clarke, 2013). The process included five-phases (Lester et al., 2020):

1. Prepare and organize the data for analysis
2. Transcribe the data
3. Become familiar with the data
4. Create memos for the data
5. Identify and categorize themes

We started our analysis by preparing and organizing the data. After all the data was organized, we transcribed each interview through Microsoft Word's automated process. We reviewed each transcript identifying any major errors in the automation and created memos for any significant data. We noted any repetitive codes in the data, specifying categories to form initial themes.

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3.2 Objective 2: Develop and Pilot Lesson Plans

After the team completed the interviews with CAMBU members and program professionals, we used the responses to further our research into lesson plan literature. We followed the steps listed below to guide our research (Madill et al., 2000; Tuffour, 2017):

1. Identify and develop the topic
2. Conduct a preliminary search for information
3. Locate and test the validity of materials
4. Synthesize information

To ensure that sources we found were reliable, the team used trusted peer-reviewed journals.

3.2.1: Identify Reliable Lesson Frameworks for CAMBU Programs

To develop reliable lesson frameworks for CAMBU, we observed two after-school program classes. The success of the program was determined by the observed engagement of the students as well as the consistency of attendance throughout the programs. The interviews with CAMBU students gave us a perspective on their personal interests. The interviews also gave us perspective on engaging teaching styles for CAMBU students.

3.2.2: Pilot Beginner Lesson Plans in CAMBU Programs

After we created lesson plans, we prepared pilot lessons for each class session. We reviewed the lesson plan, learning objectives, and discussed access to materials needed with Ms. Fuentes. We traveled to the CAMBU community center to test the pilot lessons. The lessons were conducted at the typical program times. Ms. Fuentes introduced the team, explained the reason for the pilot lesson, and taught the Google Sheets and Physics lesson plans.

While observing the pilot lesson we noted classroom behaviors. These included engagement, participation, and interactions. We also noted the flow, challenges, and the outcomes. After the lesson was completed, we interviewed the students and teacher (Appendix E and F) to gather opinions on the lesson format, understanding, and engagement with the topic. Based on the data collected from the pilot lessons and interviews, we identified strengths, weaknesses, and areas of improvement.

Following the lesson, we noted any common feedback from the interviews and observations from the lesson. We also noted if there was any emphasized feedback from the teacher or students during the interviews. Based on these notes, we considered all feedback and observations and revised the lesson plan to better fit the CAMBU teacher and students.

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4: Findings and Discussion

We present our findings on the positive influence of after school programs. We then observed the structure and benefits of hands-on learning in STEAM after school programs for CAMBU. We determined and developed lesson plans for the adult and youth courses at CAMBU. We piloted two of these lesson plans at CAMBU observing the strengths and modifications needed. We then adjusted all the lesson plans based on our observations and interviews.

4.1: The Positive Influence of After-School Programs

We found that CAMBU, an after-school community center, played a pivotal role in empowering Bucarabones' children, addressing the pitfalls of the public school system. In our interviews with educational program professionals at CAMBU, we found that after-school programs empowered students because teachers understood students more in these programs than in the public education system. We observed that these after-school programs had a lower teacher-to-student ratio (5:1) and fewer standardized constraints. As a result, educators formed more meaningful connections with students in after-school programs. For instance, an educator teaching both public school and after-school programs stated, “We understand the kids. I feel like I can say that I understand the kids more about their needs; their potential” in after-school programs, compared to public education due to freedom to teach and interact (personal connection, January 30, 2024). The personal connection that educators made in an informal environment further supplemented the public education system. In another after-school program we witnessed at the Boys and Girls Club, education did not stop at academics but extended to social and mental support.

The flexible structure we found in our after-school programs also allows for recreation. Another educator says to, “Make it fun. That's so [the students] could engage with you and tell their parents they want to go back the next day” (personal connection, February 9, 2024). By ensuring a positive culture, after-school programs push children to their potential. We observed that after-school programs supplemented the positive influence lacking in public education, through their curricula.

We found that a student’s family and friend groups influenced how they performed. This was evident in the parent workshops we observed at the Boys and Girls Club. Students innately want to fit in with peers and listen to their ideas. The impact of positive peer pressure was seen by teachers who worked in both public and private education. “The difference was night and day”, said one teacher in the private school system (personal connection, January 30, 2024). The teacher observed that private school students were generally more motivated and had a greater sense of pride in their academic work compared to public education students. The teacher also explained that the difference in motivation comes not only from the student’s environment but also their community or family. In addition, parent workshops allowed for the realization of what is possible for students, empowering through a trickle-down effect. For example, we observed parents being taught to break down assignments for struggling students. When students would

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state “I can’t do this”, parents were taught to respond with “When do you think you can?”, implying that the student had to complete the assignment but had control over when they completed it. Also, when transitioning between tasks, parents said “What would you like to do first?”, instead of “Do you want to do your homework?”, giving choice to the student while implying everything must be completed (personal connection, January 30, 2024). An after-school teacher at CAMBU also stressed the connection with family because that is who students spend the most time with. By slowly engaging students through educators in after-school programs and making a strong family connection. From interviews with educational program professionals, we learned about an increase in cohesion and engagement in the after-school program with integrated parent programs (personal connection, January 25, 2024).

4.2: Hands-On Learning and STEAM Curriculum

While observing STEAM classes in after-school programs, we found hands-on activities to be successful and engaging. We considered this while formatting our lesson plan templates. The topics we included in the curriculum reflect the wants of CAMBU members and previous success in STEAM-based after-school programs. A common theme noted in our interviews with the students and educational program professionals was that the typically used standardized method of teaching is outdated and provides little support for material retention. To supplement the exposition of STEAM to students, we found a hands-on approach was beneficial.

Hands-on learning is beneficial to STEAM-based topics where experiments are an important part of learning. As one public school student noted in reference to her teachers, “They do understand you but sometimes don’t like to do activities” (personal connection, January 25, 2024). With the lack of activities, whether because of budget or motivation, teachers rely on lectures and standardized testing to ensure the students are learning. As another public-school student states, “At the start of the semester we were promised to do experiments, but we haven't started on it yet and so mostly we just talked about it” (personal connection, January 25, 2024). While standardized teaching has been a typical method used in Puerto Rico, the teachers we interviewed reminded us that it is not the most effective teaching strategy. An educator from Puerto Rico stated “For kids, we always try to use hands-on. More hands-on activities rather than talking theory”. We found that students of all ages tend to grasp concepts quickly with tangible activities. As a teacher from Puerto Rico stated, hands-on learning allows for the students to “create the experience they want” (personal connection, January 30, 2024). With this information in mind, we determined that the consistency of having a hands-on teaching approach will benefit the students and supplement the lack of STEAM subjects in public school.

4.2.1: CAMBU Interests with STEAM-Based Topics

We identified that tying hands-on experiences to real-world examples made topics accessible, exciting, and provided long-term engagement for students. In the current CAMBU classes, students were able to grasp complex ideas when they could tie them to a real-world experience. For example, when teaching students how to find, download, and paste images into a

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Google document, the instructor allowed students to search for an image related to a personal interest. The students were excited when they found images and actively participated with the instructor. The instructor also noted that when her students could see connections to their daily lives, they actively participated through questions more frequently. We observed students in the younger classes to be more excited and verbal with interviewers when asked questions about tying their career interests to lesson plans (personal connection, February 20, 2024).

Currently, in CAMBU, there are no STEAM programs. With their available supplies, they run art programs and some basic computer classes. To determine the topics for the new curriculum, we assessed previously successful after-school programs and feedback from interviews with CAMBU students. During our visit with the Boys and Girls Club, we observed the technology classes were popular and regularly attended by students. We deemed these classes successful because educators observed a high student engagement and attendance rate. Some of these classes included basic computer function classes, Microsoft application courses, and science-based lessons (Figure 5).

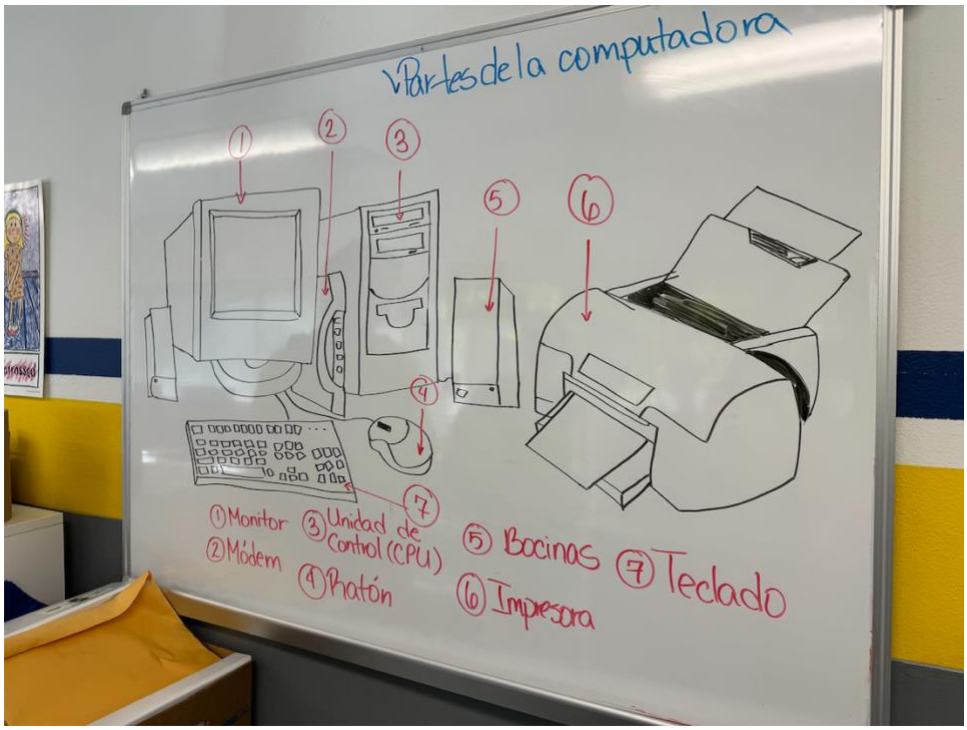

Figure 5: A whiteboard used to teach at a computer structure class at the Boys and Girls Club

We had the opportunity to interview a CAMBU student in middle school. When asked what her favorite class was, she responded with, “My favorite subject would be science [biology]”. During an interview with another CAMBU student who regularly attends the after-school program, he noted that physics was something he wanted to learn more about (personal connection, January 25, 2024).

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4.3 Determining Topics and Developing Lesson Plans

Based on interviews with CAMBU students and educational program professionals, we created a list of STEAM topics. We then considered CAMBU's budget of approximately 500 dollars per month and the materials they already possessed. Materials included basic art supplies such as paints, popsicle sticks, and paintbrushes. In terms of technology, they had four laptops and two desktop computers. We determined the topics of curriculum that would provide the most learning and engagement in the CAMBU programs. We decided to choose the following topics:

- Basic Coding (Scratch)
- Basic Coding (JavaScript)
- Architecture
- Physics
- Chemistry
- Biology
- Google Sheets
- Research Using Google Search
- Basic AI Literacy

Using the topics found we created 21 lesson plans, two examples of these lesson plans are found in Appendix H and I. To ensure that the lesson plans were well developed and easily replicable, we created a lesson plan template (Appendix G). The lesson plan template included an overarching unit topic, such as "Google Sheets", "Biology", or "Architecture", with two to four objectives about what the students should be able to accomplish after the unit was completed. Within each unit, we created individual lesson plans, such as "Basic Navigation of Google Sheets" or "Introduction to Plant Physiology", containing one to three learning outcomes.

We structured the individual lesson plans to build on each other, containing beginner, intermediate, and advanced lessons. This allowed for increased difficulty, as students' progress through the unit.

We created student objectives and learning outcomes by using Bloom's Taxonomy, which contained levels of understanding, as seen in Figure 6 (Armstrong, 2010). Through the levels of understanding, we were able to build the objectives of each lesson plan. The beginner lesson of the unit began with the lowest level of understanding, "remember", which is being able to recall basic concepts on the topic and the last advanced lesson of the unit ended with the highest level, "create", which is being able to create original work about the topic.

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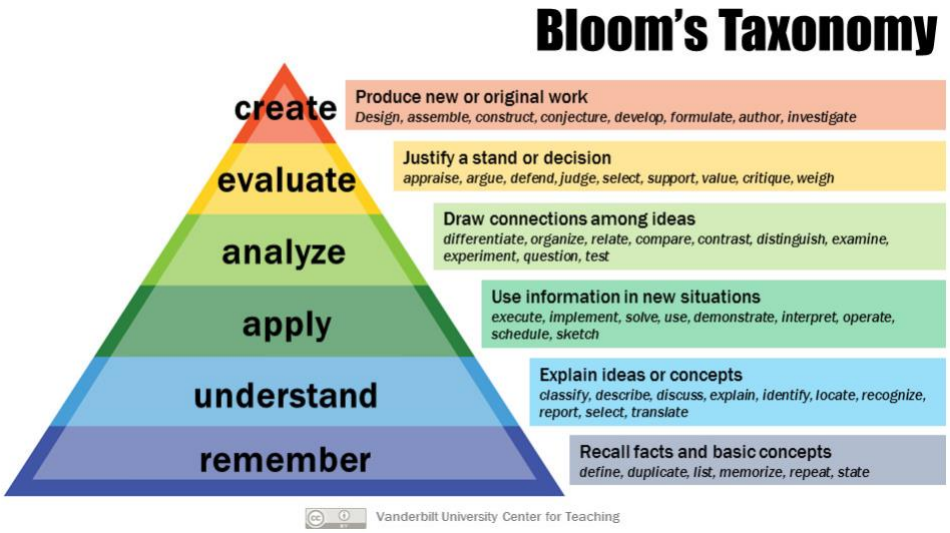

Figure 6: Bloom's Taxonomy levels of understanding (Armstrong, 2010)

We structured the individual lesson plans to first contain a list of necessary materials for the lesson. Followed by an introduction section that acts as a hook to the lesson, activating prior knowledge for the students and piquing their interest in the topic.

We created a section using the "I do, we do, you do" format, which is a form of hands-on learning (Morris, 2023). In the "I do" section, we described direct teacher instructions, this is when the teacher would provide short lecture content to explain topic information. We included videos or websites that further explained the topic. The "we do" section, presents a group activity led by the teacher to apply the information. This was followed by the "you do" section, which presents independent, or group work that the students do without the teacher's guidance unless asked. In the independent or group work, we included hands-on activities to help with student engagement, information processing, and applying skills taught from the "I do" and "we do" sections (Main, 2023). We finish the "you do" section with a stretch activity, which contains other resources and activities that the students can use on their own to learn more about the topic.

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Figure 7: Teacher Demoing Interactive Portion of Lesson at CAMBU

The lesson ends with the entire class coming together to discuss the conclusion, sharing what the students had done in the activity and discussing what they learned. The conclusion discussed real-world applications of the topic, including types of jobs and other resources for the topic. We placed some resources in the teacher prep work section, which included information and links to videos, websites, and articles. The teacher prep work was meant for the teacher to review the topic information before the lesson. This section could also be used in class to explain content and allow students to have access to multiple sources.

4.4: Pilot of Programs and Observations

When visiting CAMBU on February 20, 2024, we piloted the adult Google Sheets and the youth Physics lesson plans. The adult class and youth class had 4 and 2 students attending respectively. Both lessons needed improvement in flow between lecture to activity transitions. In interviews after the programs, both age groups also stated that adding key terms to the beginning of the lesson would be beneficial (personal connection February 20, 2024).

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Figure 8: Teacher Giving Introductory Lecture for Google Sheets Lesson

In the adult lessons in particular, students were more comfortable asking the instructor questions. The adults also moved through the lesson plans at a slightly slower than expected pace. The adult students also noted that "they enjoyed seeing the connection between the lesson and how they could apply it to their daily lives" (personal communication February 20, 2024).

Figure 9: Students Participating in Physics Activity

With the youth classes, students were also engaged with the topic. They particularly enjoyed the video shown during the "I do" section explaining the theory behind physics. We observed students to be more engaged during the hands-on activity and when the theory was tied

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to a relative area of interest. However, we noted there was a need for more introduction to the topic at the beginning of the lesson. The “I do” section of the lesson progressed much faster than anticipated because of short introductions. The lack of introductions to topics taught also led to more clarifying questions from students.

4.4.1: Adjustment of Lesson Plans Based on Pilot

We enhanced the flow and clarity of the pilot lessons based on the comments and observations we received. Overall, we decided to add key terms and definitions to the beginning of lessons. We also made sure to offer multiple additional activities if the class progressed faster than anticipated. We decided to add slide decks to the lesson plans when applicable to give a visual representation during the “I do” section.

To increase the instructors’ understanding of the lessons being taught, we added additional learning resources throughout the lesson plans. This was included for the teacher to read before the lesson. These resources were also included in the extracurricular sections of the lesson plans for students.

To improve retention, the theory being taught had to be slowed down for the youth students. We included more probing questions, detailed explanations, and graphics in the beginning presentations. This aimed to give more concrete definitions with more dedicated learning time.

Once we adjusted all the lesson plans accordingly, we sent them to the main CAMBU instructor, Ms. Fuentes. She then asked any clarifying questions to which we answered and further developed the lesson plans.

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5: Conclusion

Our project aimed to empower the Bucarabones community by building STEAM based programs to broaden opportunities for the youth and adults. Through our interviews and observations, we created a set framework of engaging STEAM-based curriculum that empowers CAMBU students amid the public education learning gap.

The main deliverable of our project is a STEAM-based curriculum that includes 21 lessons, comprising nine topics we deemed the best choice for CAMBU. The goal of the lesson plans was to provide CAMBU with the material and resources to teach weekly STEAM-based programs to students. The lesson plans were aimed to be low-budget, easily understandable and applicable to the students' daily lives. To empower students for future opportunities, these lesson plans encouraged students to broaden their view of possibilities.

The collection offers a year's worth of lesson plans and is the first step in opening doors for CAMBU's growth. This anticipated growth includes higher student attendance, engagement, and interest in STEAM-based careers. Through our project, we believe the developed curriculum is a considerable segue into the empowerment of future CAMBU students in the face of socioeconomic challenges.

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References

Abizeid, M. (2020, September 3). *Report: Puerto Rico's mass closures of public schools eroding communities | Othering & Belonging Institute*. https://belonging.berkeley.edu/report-puerto-ricos-mass-closures-public-schools-eroding-communities

Aja, A. A., Lefebvre, S., Darity, W., Ortiz-Minaya, R., & Hamilton, D. (2018). *Bold Policies for Puerto Rico: A Blueprint for Transformative, Justice-Centered Recovery*. Diálogo, 21(2), 3–14. https://doi.org/10.1353/dlg.2018.0023

Allard. (2023, October 26). *STEM vs STEAM Education: What's the Difference?* Thanksgiving Point. https://thanksgivingpoint.org/blog-stem-vs-steam-education/

Allen, B., Urban, B., & Urban, D. (2014, July 8). *Engineering / Structure Team Guide*. Destination Imagination of New York. https://www.nydi.org/structure-team-guide/

Armstrong, P. (2010). *Bloom's Taxonomy*. Vanderbilt University. https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Arnon, L., Almog-Bar, M., & Cnaan, R. A. (2023). Volunteer Engageability: A ConceptualFramework. *Nonprofit and Voluntary Sector Quarterly*, 52(6), 1633–1659. https://doi.org/10.1177/08997640221132499

Barriball, K. L., & While, A. (1994). Collecting data using a semi-structured interview: a discussion paper. *Journal of Advanced Nursing-Institutional Subscription*, 19(2), 328-335. https://www.academia.edu/download/34291860/Barriball___While_1994_Collecting_data_using_a_semi-structured_interview_JAN.pdf

Basu, R. (2007). Negotiating Acts of Citizenship in an Era of Neoliberal Reform: The Game of School Closures. *International Journal of Urban and Regional Research*, 31(1), 109–127. https://doi.org/10.1111/j.1468-2427.2007.00709.x

Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M. A. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits* (p. 12190). National Academies Press. https://doi.org/10.17226/12190

Bertrand, M. G., & Namukasa, I. K. (2020). STEAM education: Student learning and transferable skills. *Journal of Research in Innovative Teaching & Learning*, 13(1), 43–56. https://doi.org/10.1108/JRIT-01-2020-0003

`

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development.* Sage. https://books.google.com/books?hl=en&lr=&id=_rfClWRhIKAC&oi=fnd&pg=PR6&ots=ECmLBkjk3n&sig=EGkz76dZARvKgKMSPHxoroKL_mI

Broom, C. (2015). Empowering students: Pedagogy that benefits educators and learners. *Citizenship, Social and Economics Education*, *14*(2), 79–86. https://doi.org/10.1177/2047173415597142

Brusi, R., & Godreau, I. (n.d.). *Dismantling Public Education in Puerto Rico*.

Brusi, R. (2020). No savings, just pain: School closures and "reform" in Puerto Rico. *Alternautas*, *7*(2). https://doi.org/10.31273/alternautas.v7i2.1109

Brusi, R. (2022). Erasure and resistance: the state of public education in Puerto Rico. *International Journal of Qualitative Studies in Education*, *35*(8), 824–829. https://doi.org/10.1080/09518398.2021.1956633

Bucarabones barrio, Maricao Municipio, Puerto Rico—Census Bureau Profile. (2020). https://data.census.gov/profile/Bucarabones_barrio,_Maricao_Municipio,_Puerto_Rico?g=060XX00US7209308872

Chistyakov, A. A., Zhdanov, S. P., Avdeeva, E. L., Dyadichenko, E. A., Kunitsyna, M. L., & Yagudina, R. I. (2023). Exploring the characteristics and effectiveness of project-based learning for science and STEAM education. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(5), em2256. https://doi.org/10.29333/ejmste/13128

Chittum, J. R., Jones, B. D., Akalin, S., & Schram, Á. B. (2017). The effects of an afterschool STEM program on students' motivation and engagement. *International Journal of STEM Education*, 4(1), 11. https://doi.org/10.1186/s40594-017-0065-4

Clarke V., Braun V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. *The Psychologist*, 26(2), 120–123. https://uwe-repository.worktribe.com/preview/937606/Teaching%20.

Cohodes, S., Ho, H., & Robles, S. (2022). *STEM Summer Programs for Underrepresented Youth Increase STEM Degrees* (w30227; p. w30227). National Bureau of Economic Research. https://doi.org/10.3386/w30227

`

Daugherty, M. K. (2013). The prospect of an A" in STEM education. *Journal of STEM Education: Innovations and Research*, 14(10–15). https://eric.ed.gov/?id=EJ1006879

Davis, J.-M., Reyes, M., Abrogar, J., Bourgoin, J., Brown, M., Kellum, E., Polito, F., & Jiusto, S. (2023). Puerto Rico's Rescued Schools: A Grassroots Adaptive Reuse Movement for Abandoned School Buildings. *Social Sciences*, *12*(12), 662. https://doi.org/10.3390/socsci12120662

DE: Puerto Rico Department of Education. (2017). *Puerto Rico Department of Education: Strategic Plan (2017-2020)*. https://transicion2020.pr.gov/Agencias/081/Informe%20status%20planes%20unidades%20administrativas/PRDE%20-%20Strategic%20Plan%20(1).pdf

Denson, C. D., Hailey, C., Stallworth, C. A., & Householder, D. L. (2015). Benefits of Informal Learning Environments: A Focused Examination of STEM-based Program Environments. *Journal of STEM Education: Innovations and Research*, 16(1)(11). https://eric.ed.gov/?id=EJ1065411

Dewar, J. (2023, March 16). *The Most In-Demand Skills for 2023 | LinkedIn*. https://www.linkedin.com/business/talent/blog/talent-strategy/linkedin-most-in-demand-hard-and-soft-skills

Diego-Mantecon, J.-M., Prodromou, T., Lavicza, Z., Blanco, T. F., & Ortiz-Laso, Z. (2021). An attempt to evaluate STEAM project-based instruction from a school mathematics perspective. *ZDM – Mathematics Education*, *53*(5), 1137–1148. https://doi.org/10.1007/s11858-021-01303-9

Dowdall, E., & Warner, S. (2013). *Shuttered Public Schools: The Struggle to Bring Old Buildings New Life*. The Pew Charitable Trusts. https://www.pewtrusts.org/~/media/assets/2013/02/11/philadelphia_school_closings_report.pdf?la=en

Evans, M. A., Schnittka, C., Jones, B. D., & Brandt, C. B. (2016). Studio STEM: A Model to Enhance Integrative STEM Literacy Through Engineering Design. In L. A. Annetta & J. Minogue (Eds.), *Connecting Science and Engineering Education Practices in Meaningful Ways* (Vol. 44, pp. 107–137). Springer International Publishing. https://doi.org/10.1007/978-3-319-16399-4_5

Figueroa-Lazu, D. (2021, October 13). *Puerto Rico's 2020 Race/Ethnicity Decennial Analysis*. CentroPR. https://centropr.hunter.cuny.edu/reports/puerto-ricos-2020-decennial-analysis-datasheet-series/

`

George, T. (2023, June 22). Semi-Structured Interview | Definition, Guide & Examples. Scribbr. Retrieved January 29, 2024, from https://www.scribbr.com/methodology/semi-structured-interview/

Goggins, D. (2018). *Can't hurt me: Master your mind and defy the odds*. Lioncrest publishing.

Gullapyan, T. (2020). *Best teaching practices to increase student interest in STEM subjects.* https://digitalcommons.pepperdine.edu/etd/1135/

Herro, D., & Quigley, C. (2017). Exploring teachers' perceptions of STEAM teaching through professional development: implications for teacher educators. *Professional Development in Education, 43*(3), 416–438. https://doi.org/10.1080/19415257.2016.1205507

Hinojosa, J., Melendez, E., & Pietri, K. S. (2019). *Population Decline and School Closure in Puerto Rico.* https://bvirtualogp.pr.gov/ogp/Bvirtual/reogGubernamental/PDF/Informes%20y%20Estudios/RB2019-01.pdf

Hopkins, S. R., Rae, V. I., Smith, S. E., Meldrum, S., & Tallentire, V. R. (2023). From safety net to trampoline: Elevating learning with growth mindset in healthcare simulation. *Advances in Simulation*, 8(1), 26. https://doi.org/10.1186/s41077-023-00264-1

Jürges, H., Richter, W. F., & Schneider, K. (2005). Teacher Quality and Incentives: Theoretical and Empirical Effects of Standards on Teacher Quality. *FinanzArchiv / Public Finance Analysis*, 61(3), 298–326. https://www.jstor.org/stable/40913080

Kohn, A. (2000). *The case against standardized testing: raising the scores, ruining the schools*. https://purpletod.co.za/docs/Standardized%20Testing.pdf

Kremer, K. P., Maynard, B. R., Polanin, J. R., Vaughn, M. G., & Sarteschi, C. M. (2015). Effects of After-School Programs with At-Risk Youth on Attendance and Externalizing Behaviors: A Systematic Review and Meta-Analysis. *Journal of Youth and Adolescence*, *44*(3), 616–636. https://doi.org/10.1007/s10964-014-0226-4

Lake, R. (2019, March 14). *Resilience, Hope, and the Power of the Collective: What Puerto Rico can Teach the States about Education Reform*. Center on Reinventing Public Education. https://crpe.org/resilience-hope-and-the-power-of-the-collective-what-puerto-rico-can-teach-the-states-about-education-reform/

Lee, Y.-F. E., Wang, T.-H., Foo, M.-T., & Lam, K.-F. T. (2023). Embracing DDMT Teaching

`

Model and Design Thinking for Organization Development. *Sustainability*, 15(11), 9031. https://doi.org/10.3390/su15119031

Lester, J. N., Cho, Y., & Lochmiller, C. R. (2020). Learning to Do Qualitative Data Analysis: A Starting Point. *Human Resource Development Review*, 19(1), 94-106. https://doi.org/10.1177/1534484320903890

Lynch, N. (2022). Remaking the obsolete: Critical geographies of contemporary adaptive reuse. *Geography Compass*, 16(1), e12605. https://doi.org/10.1111/gec3.12605

Madill, A., Jordan, A., & Shirley, C. (2000). Objectivity and reliability in qualitative analysis: Realist, contextualist and radical constructionist epistemologies. *British Journal of Psychology*, *91*(1), 1–20. https://doi.org/10.1348/000712600161646

Main, P. (2023, July 19). *Hands-On Learning*. https://www.structural-learning.com/post/hands-on-learning

Morris, V. (2023, June 21). *I Do, We Do, You Do: Introducing New Learning Effectively*. https://atomlearning.com/blog/gradual-release-of-responsibility

President's Council of Advisors on Science and Technology [PCAST]. (2010). *Prepare and inspire: K-12 education in Science, Technology, Engineering, and Math (STEM) for America's future*. Executive Office of the President of the U.S.A. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast-stem-ed-final.pdf

Qin, Y. (2020). *Design for community resilience in the age of disasters: a case study in Puerto Rico [Thesis, Massachusetts Institute of Technology]*. https://dspace.mit.edu/handle/1721.1/132856

Rahmawati, Y., Ridwan, A., Hadinugrahaningsih, T., & Soeprijanto. (2019). Developing critical and creative thinking skills through STEAM integration in chemistry learning. *Journal of Physics: Conference Series*, *1156*, 012033. https://doi.org/10.1088/1742-6596/1156/1/012033

Reisner, E.R., Vandell, D.L., Pechman, E.M., Pierce, K.M., Brown, B.B., & Bolt, D.M. (2007). *Charting the Benefits of High-Quality After-School Program Experiences: Evidence from New Research on Improving After-School Opportunities for Disadvantaged Youth*.

Rivera Rivera, E. R. (2022). Schools of Encanto: Puerto Rico's Schools Closure Policy Study Case. http://jhir.library.jhu.edu/handle/1774.2/66931

`

Roberts, T., Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Cavalcanti, M., Craig Schroeder, D., Delaney, A., Putnam, L., & Cremeans, C. (2018). Students' perceptions of STEM learning after participating in a summer informal learning experience. *International Journal of STEM Education*, 5(1), 35. https://doi.org/10.1186/s40594-018-0133-4

Rodríguez, J. (2015). *Walkability Study for School Accessibility: Case Study of the San Juan, Puerto Rico Elementary Schools* [M.S., University of Southern California]. https://www.proquest.com/docview/2155324537/abstract/74DB4F669DA6489APQ/1

Rosa, B. (2021, August 25). *The path to better education in Puerto Rico*. Financial Oversight and Management Board for Puerto Rico. https://juntasupervision.pr.gov/el-camino-hacia-una-mejor-educacion-en-puerto-rico/

Rosenbaum, M. S., Kim, K. (Kawon), Ramirez, G. C., Orejuela, A. R., & Park, J. (2021). Improving well-being via adaptive reuse: transformative repurposed service organizations. *The Service Industries Journal*, *41*(3–4), 223–247. https://doi.org/10.1080/02642069.2019.1615897

Salinas, J., & Guajardo, C. (2022). *A review of Standardized Testing and its relevance to public education*. https://scholarworks.utrgv.edu/cgi/viewcontent.cgi?article=1071&context=tl_fac

Snyder, T. D., de Brey, C., & Dillow, S. A. (2019). Digest of Education Statistics 2017, 53rd Edition. *NCES* 2018-070. National Center for Education Statistics. https://eric.ed.gov/?id=ed592104

Tuffour, I. (2017). A Critical Overview of Interpretative Phenomenological Analysis: A Contemporary Qualitative Research Approach. *Journal of Healthcare Communications*, *02*(04). https://doi.org/10.4172/2472-1654.100093

University of Colorado-Denver, Grant, C., Osanloo, A., & New Mexico State University. (2014). Understanding, Selecting, and Integrating a Theoretical Framework in Dissertation Research: Creating the Blueprint for Your "House." *Administrative Issues Journal Education Practice and Research*, *4*(2). https://doi.org/10.5929/2014.4.2.9

Wang T.-H. (2019, November 22). *Effective Interdisciplinary STEM/STEAM Education: DDMT*.

Ward, J. G., Ward, Y. D., Wells, J., & Bejot, K. (2023). Superior Performance Competencies

`

Achieved Through Destination Imagination Experiences. *Archives of Business Research, 11*(9), 219–235. https://doi.org/10.14738/abr.119.15542

Willink, J., & Babin, L. (2015). *Extreme Ownership*. St Martin's Press.

Yaki, A. A. (2022). Fostering Critical Thinking Skills Using Integrated STEM Approach among Secondary School Biology Students. *European Journal of STEM Education*, *7*(1), 06. https://doi.org/10.20897/ejsteme/12481

Yedidia, D., Moore, E., Toppin, E. J., Ake, W., Rivera, L., Arabía, M., & Valle, G. (2020). *Puerto Rico's Public School Closures: Community Effects and Future Paths*. https://escholarship.org/uc/item/8rf2c1p0

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Appendix A: Semi-Structured Interviews with CAMBU Students

We are a group of students from Worcester Polytechnic Institute in Massachusetts working with Centro de Mutuo Bucarabones Unido (CAMBU) to develop STEM-based learning programs. Currently, we are conducting interviews of Bucarabones community members to better understand aspirations for CAMBU's programs and opinions on the improvement of the educational system.

We recognize that some of the questions we are asking may be sensitive topics. Your participation in this interview is completely voluntary and you may withdraw at any time. You can choose to answer or not answer any questions in the interview. With the information you choose to share, we will record the information. This is to ensure CAMBU understands the Bucarabones community members, so the organization can develop to continue being helpful. We will not have personal information publicly shared.

If you have any questions, please do not hesitate to contact our team, our contact information is gr-cambu-b23@wpi.edu. The email information for our university is irb@wpi.edu.

Introduction to us and the project: We are students from Worcester Polytechnic Institute, a college in Massachusetts, we are working on a project to help determine the most effective ways that CAMBU can adapt and evolve their programs to a more STEAM (Science, Technology, Engineering, Arts, and Math) based curriculum. Through this interview we hope to gain relevant information on successes, drawbacks, and community opinions on CAMBU's present, past, and future.

1. What is your name?
2. Can you tell us about yourself?
3. How long have you lived in the area?
4. Do you have family in the area?
5. What are some of your favorite parts about living in Puerto Rico?
6. What are some of your favorite parts about living in Bucarabones?
7. Do you go to school in Bucarabones?
8. What topics were you learning in middle school? High school?
9. What skills do you use in real life?
10. What is your favorite subject in school and why?
11. What are your out of school hobbies?
12. Tell us about something that you find fun.
13. How long does it take you to arrive to CAMBU?
14. How long have you been attending the programs at CAMBU?
15. Do you attend the programs every week?
16. How would you describe CAMBU?
17. How have you been using CAMBU?

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18. What programs have you gone to?
19. What do you like about CAMBU?
20. Are there any challenges in using CAMBU?
21. What could be beneficial to add to CAMBU?
22. Are there any programs that you would be interested in adding?
23. Have you heard the term STEM used for topics of Science, Technology, Engineering, Mathematics? (Note: if they do not understand skip 21c)
24. Would you be interested in STEM programs at CAMBU?
25. (Note: have list of programs we have been researching and ask if they would be interested in any we suggest)
26. Any other feedback that we did not discuss?

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Appendix B: Semi-Structured Interviews with CAMBU Volunteers

We are a group of students from Worcester Polytechnic Institute in Massachusetts working with Centro de Mutuo Bucarabones Unido (CAMBU) to develop STEM-based learning programs. Currently, we are conducting interviews of Bucarabones community members to better understand aspirations for CAMBU's programs and opinions on the improvement of the educational system.

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If you have any questions, please do not hesitate to contact our team, our contact information is gr-cambu-b23@wpi.edu. The email information for our university is irb@wpi.edu.

Introduction to us and the project: We are students from Worcester Polytechnic Institute, a college in Massachusetts, we are working on a project to help determine the most effective ways that CAMBU can adapt and evolve their programs to a more STEAM (Science, Technology, Engineering, Arts, and Math) based curriculum. Through this interview we hope to gain relevant information on successes, drawbacks, and community opinions on CAMBU's present, past, and future.

1. What is your name?
2. Can you tell us about yourself?
3. How long have you lived in the area?
4. Do you have family in the area?
5. What are some of your favorite parts about living in Puerto Rico?
6. What are some of your favorite parts about living in Bucarabones?
7. How would you describe your role in CAMBU??
8. Why did you become a volunteer for CAMBU?
9. How long have you been volunteering for CAMBU?
10. What programs have you helped with?
11. What social events have you attended/helped with?
12. What has CAMBU done well?
13. Are there any obstacles volunteering at CAMBU presents?
14. Are there programs that would benefit the community that are not currently offered?
15. Have you heard the term STEM used for topics of Science, Technology, Engineering, Mathematics? (Note: if they do not understand skip 26 a & b)
16. What kind of STEM programs would best suit the Bucarabones community?

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17. (Note: have list of programs we have been researching and ask if they are interested in any we suggest)
18. Any other feedback that we did not discuss?

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Appendix C: Semi-Structured Interviews with CAMBU Teachers

We are a group of students from Worcester Polytechnic Institute in Massachusetts working with Centro de Mutuo Bucarabones Unido (CAMBU) to develop STEM-based learning programs. Currently, we are conducting interviews of Bucarabones community members to better understand aspirations for CAMBU's programs and opinions on the improvement of the educational system.

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1. What is your name?
2. Can you tell us about yourself?
3. How long have you lived in the area?
4. Do you have family in the area?
5. What are some of your favorite parts about living in Puerto Rico?
6. What are some of your favorite parts about living in Bucarabones?
7. How long have you been teaching?
8. What is your favorite part about teaching?
9. What motivates you to teach?
10. What is your educational background?
11. What is your approach to creating lessons plans?
12. What do you think about when creating a lesson plan?
13. Why do you choose certain topics to teach students?
14. How do you cater your teaching style to each individual classroom?
15. What strategies have you used that have created the most connections in your classrooms?

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16. What differences in teaching style do you find when teaching the elderly versus the youth.
17. Have there been any helpful methods you found when teaching the different age groups?
18. What materials do you have access to?
19. Do you have access to a projector?
20. How many computers do you have access to?
21. What art materials do you have access to?
22. Do you find indirect factors that have an impact on students learning such as classroom layout/decor, speaking styles, etc.?
23. If so, what factors? And how so?
24. What are some of the biggest challenges you've faced teaching?
25. How did you overcome these challenges?
26. Do you have any experience with teaching STEEM used for topics of Science, Technology, Engineering, Arts, Mathematics?
27. Has there been any specific topics that you found the students enjoyed?
28. Was there a certain method you used that the students found helpful?
29. Have you found any software or websites that have been helpful while teaching STEM?
30. Would you feel comfortable teaching a STEM program?
31. What criteria would you need to know before teaching a STEM program?
32. Do you believe the current program equipment set up will support STEM programs?
33. Do the programs have access to computers for all the students?
34. Any other feedback that we did not discuss?

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Appendix D: Semi-Structured Interviews with Educational Program Professionals

We are a group of students from Worcester Polytechnic Institute in Massachusetts working with Centro de Mutuo Bucarabones Unido (CAMBU) to develop STEM-based learning programs. Currently, we are conducting interviews of Bucarabones community members to better understand aspirations for CAMBU's programs and opinions on the improvement of the educational system.

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If you have any questions, please do not hesitate to contact our team, our contact information is gr-cambu-b23@wpi.edu. The email information for our university is irb@wpi.edu.

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1. What is your name?
2. Can you tell us about yourself?
3. How long have you lived in the area?
4. Do you have family in the area?
5. What are some of your favorite parts about living in Puerto Rico?
6. What are some of your favorite parts about living in Bucarabones?
7. How long have you been teaching?
8. What is your favorite part about teaching?
9. What motivates you to teach?
10. What is your educational background?
11. What is your approach to creating lessons plans?
12. What do you think about when creating a lesson plan?
13. Why do you choose certain topics to teach students?
14. How do you cater your teaching style to each individual classroom?
15. What strategies have you used that have created the most connections in your classrooms?

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16. Do you find indirect factors that have an impact on students learning such as classroom layout/decor, speaking styles, etc.?
17. If so, what factors? And how so?
18. What are some of the biggest challenges you've faced teaching?
19. How did you overcome these challenges?
20. Do you have any experience with teaching STEEM used for topics of Science, Technology, Engineering, Arts, Mathematics?
21. Has there been any specific topics that you found the students enjoyed?
22. Was there a certain method you used that the students found helpful?
23. Have you found any software or websites that have been helpful while teaching STEM?
24. Any other feedback that we did not discuss?

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Appendix E: After Pilot Interview with Students

We are a group of students from Worcester Polytechnic Institute in Massachusetts working with Centro de Mutuo Bucarabones Unido (CAMBU) to develop STEM-based learning programs. Currently, we are conducting interviews of Bucarabones community members to better understand aspirations for CAMBU's programs and opinions on the improvement of the educational system.

We recognize that some of the questions we are asking may be sensitive topics. Your participation in this interview is completely voluntary and you may withdraw at any time. You can choose to answer or not answer any questions in the survey. With the information you choose to share, we will record the information. This is to ensure CAMBU understands the Bucarabones community members, so the organization can develop to continue being helpful. We will not have personal information publicly shared.

If you have any questions, please do not hesitate to contact our team, our contact information is gr-cambu-b23@wpi.edu. The email information for our university is irb@wpi.edu.

1. Did you enjoy the lesson?
2. Were the learning outcomes clear?
3. Did you find the topic taught interesting?
4. Was the topic engaging to you?
5. Did you find the activities interesting?
6. Was the activity relevant to the topic?
7. Was the activity engaging?
8. Were the instructions clear for the activity?
9. Did you feel actively involved in the lesson?
10. Overall, how confident do you feel in the topic taught?
11. Would you want to learn more about this topic?
12. Any other feedback that we did not discuss?

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Appendix F: After Pilot Interview with Teachers

We are a group of students from Worcester Polytechnic Institute in Massachusetts working with Centro de Mutuo Bucarabones Unido (CAMBU) to develop STEM-based learning programs. Currently, we are conducting interviews of Bucarabones community members to better understand aspirations for CAMBU's programs and opinions on the improvement of the educational system.

We recognize that some of the questions we are asking may be sensitive topics. Your participation in this interview is completely voluntary and you may withdraw at any time. You can choose to answer or not answer any questions in the survey. With the information you choose to share, we will record the information. This is to ensure CAMBU understands the Bucarabones community members, so the organization can develop to continue being helpful. We will not have personal information publicly shared.

If you have any questions, please do not hesitate to contact our team, our contact information is gr-cambu-b23@wpi.edu. The email information for our university is irb@wpi.edu.

1. What were your initial impressions of the lesson plan?
2. Did you find the learning outcomes clear and understandable?
3. How would you rate the overall effectiveness of the lesson plan?
4. Were there any activities or resources in the lesson plan that stood out to you as particularly effective or engaging?
5. What are some areas in which the lesson plan or resources could be improved?
6. Were there any aspects of the lesson plan that you adapted or modified to better suit your teaching style or your students' needs?
7. What additional resources or materials would have been beneficial to enhance the lesson plan?
8. What are some challenges you experienced in implementing this lesson plan in you classroom?
9. Overall, what additional questions, recommendations, or feedback do you have?

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Appendix G: Lesson Plan Template

Unit Topic

Unit Objectives

- 2-4 objectives

List of Required Prior Knowledge

- General knowledge

Table of Contents

Lesson Topic

Lesson Outcomes

- 1-3 outcomes

List of Materials

- Materials needed for the lesson

Introduction

- Hook to topic

I Do

- Teacher instruction

We Do

- Teacher-led demonstration

You Do

- Individual or group activity

Conclusion

- What students learned
- Tie to real-world applications

Stretch Activity

- Stretch activity for students on different learning levels

Teacher Prep Work

- Resources for the teacher to learn about the topic

Future Lesson Topics

Unit Topic

- Unit Objectives

Lesson Topics

- Lesson Objectives

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Appendix H: Google Sheets Lesson Plan

Unit Objectives

- Understand data entry and organization
- Understand data visualization
- Apply data entry, organization, and visualization to day-to-day personal functions

1.1: Basic Navigation

Learning Outcomes

- Students will be able to open, create, and navigate google sheets
- Students will be able to explain basic vocabulary of google sheets

List of Materials

- Internet
- Laptop or desktop
- Projector for teacher

Introduction

State the objective of the lesson: to proficiently open, create, and navigate Google Sheets, while also demonstrating comprehension of basic Google Sheets terminology.
We will be learning about google sheets, it is a user-friendly software that offers a way to analyze and present data in an organized way. Individuals and companies use sheets every single day to help save time and minimize errors.
Can you think of time that you had to organize information or ideas? How did you go about doing that? Did you face any challenges? What worked?
Google sheets is used by accountants, project managers, business analysts, and data journalists. These jobs use google sheets to stay organized and to be able to update calculations as data points are added.

I Do

- What is:
  - What is a google sheet
  - What a column is
  - What a row is
  - What a cell is
  - What an active cell is

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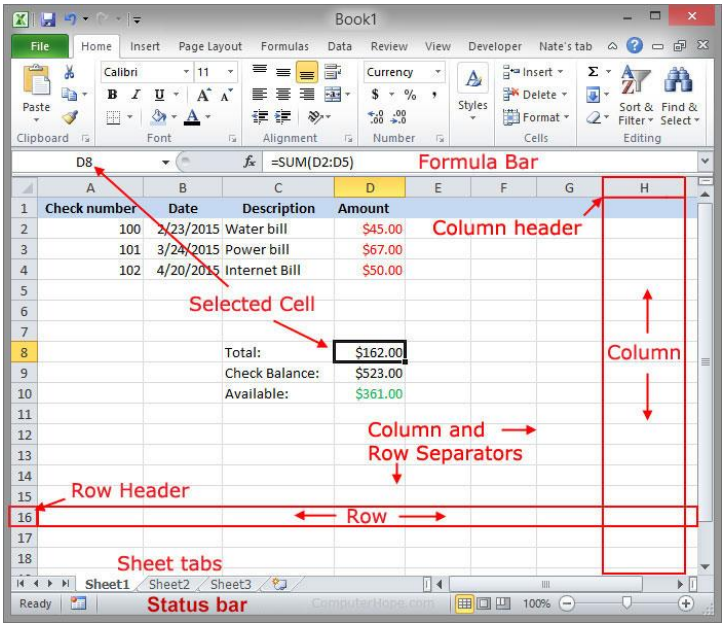

We Do

- Navigate to google sheets through Google
- Open a Google sheet
- Name the google sheet
- How to zoom in and out on a google sheet
    - Zooming is the same as Word
- How to move to a different cell
    - Move with arrows
    - Move with mouse
- How to type in a cell
    - Note: it is like creating a list, each cell should contain an individual idea/value
- Save the google sheet to files
- Locate the google sheet in files

You Do

- Create a new sheet and name the sheet
- Input a list of ideas into individual cells creating a list
- Save the sheet to your files
- Locate the google sheet in files

Conclusion

What did you learn (Yes, And! Activity)? What did you have a hard time with? Would you like to go over a topic discussed in more detail next lesson?

Yes, And! Activity:

- Have students form a circle
- Inform students they are performing a review activity to summarize what they learned

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- Each student goes around and says what the last person learned in their own words then says what they learned.
    - Tell students to be specific and use their own words
    - For example, don't say I learned google sheets; what about google sheets did you learn?
- For example, if the first person says: I learned that when I'm trying to put information into a cell, I must double-click it with the mouse first
    - The next person says, **YES**, he/she learned you must double click when putting information into a cell, **AND** I learned that when navigating you can use either your pointer or the arrows on the keyboard.
- Wrap up the activity with any concluding thoughts or questions.

Teacher Prep Work

- Google Sheets Cheat sheet: https://support.google.com/a/users/answer/9300022?sjid=6374197681192217299-NA
- Google Sheets for beginners (watch to 6:46 minutes): https://www.youtube.com/watch?v=FIkZ1sPmKNw&ab_channel=Coupler%E2%80%A4ioAcademy
    - Navigate to google sheets through google drive
    - Create a blank spreadsheet within google drive
    - Name spreadsheet
    - Save spreadsheet to a folder in google drive
    - Name individual sheet
    - Create multiple sheets
    - What a column, row, and cell is
    - How to freeze markers to create headings
    - How to input data
    - Formatting of data/tables
    - Copy and paste cells
- Google Sheets Beginner's Tutorial (Watch to 15.21 minutes): https://www.youtube.com/watch?v=G93P4DxryVE&ab_channel=Teacher%27sTech
    - Why use Google Sheets
    - Navigating to Google Sheets
    - Create blank google spreadsheet
    - Spreadsheet layout
    - Add data to spreadsheet
    - Formatting rows and columns

`

1.2: Mouse Functions

Lesson Objectives

- Students will be able to highlight and select multiple cells
- Students will be able to copy and paste in cells
- Students will be able to enter data to create a list
- Students will be able to change text formatting in cells and wrap text
- Students will be able to change cell size
- Students will be able to make summations

List of Materials

- Internet
- Laptop or desktop
- Projector for teacher

Introduction

State the objective of the lesson: to demonstrate proficiency in fundamental Excel skills including highlighting and selecting multiple cells, copying and pasting data, entering data to create lists, changing text formatting, adjusting cell size, and performing summations.
Rapid review:

- The purpose of this activity is to warm up students and practice retrieval from the previous lesson .
- Ask students: How do you navigate Google Sheets?
- Tell students: Turn to someone near you and talk together for 90 seconds.
- After 90 seconds, wrap up and facilitate a discussion between the group.

Vocabulary splash:

- The purpose of this activity is to introduce new terms while mixing in old vocabulary.
- This allows teachers to gauge how familiar students are with each term and engages curiosity by having students guess what new terms mean.
- Have students turn to someone near them and define these terms and how they relate to Google Sheets
    - (Active) Cell
    - Wrapping text
    - Formulas
- These terms remain unanswered at first. Throughout the lesson, the meanings are revealed. At the end of the lesson, there is a review of these 3 terms.

I do

- A video demo:

https://www.youtube.com/watch?v=UvM-oAeGsDg

- How to highlight a cell
- How to select multiple cells
- Copy and paste in cells
- Enter data to create a list
- How to wrap text
- https://www.youtube.com/watch?v=TuC2huzBgjM

`

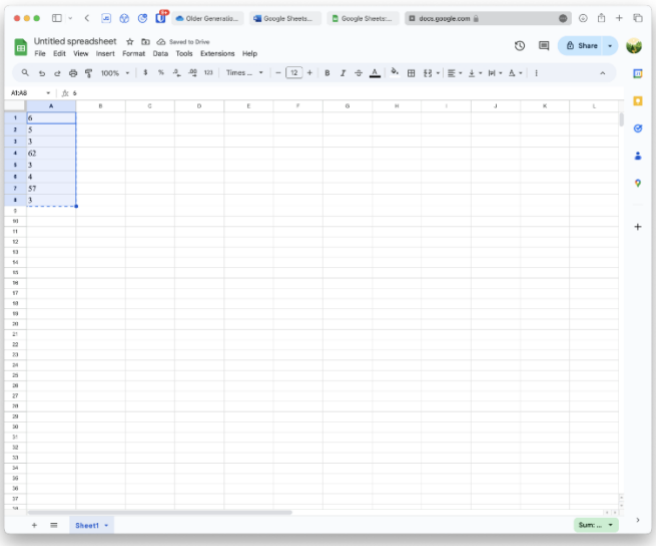
- How to make a cell size
- How to make a summation
    - https://www.youtube.com/watch?v=-u-9f3QrdAQ

We do

- Live demo following teacher:
- How to highlight a cell
    - This is an **active cell**
- How to select multiple cells
- Copy and paste in cells
- Enter data to create a list
- How to wrap text
    - **Wrap text** that is too long
- How to make a cell size
- These are all called **mouse functions**
- How to make a summation
    - https://www.youtube.com/watch?v=-u-9f3QrdAQ

You do

- Now you will put it all together on your own!
- Enter in this data and copy and paste it to another column
- Sum this data now
- 6
- 5
- 3
- 62
- 3
- 4
- 57
- 3



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Conclusion

- Review terms
  - (Active) Cell – the cell that is currently selected where you can input or edit data
  - Wrapping text – a function of Google Sheets that automatically wraps text onto the next line if it goes over the cell size
  - Formula – a set of instructions that performs calculations, manipulates data, or carries out specific actions within a spreadsheet. Formulas are typically written in cells and start with an equal sign (=). They can consist of mathematical operators, functions, cell references, and constants.
- Quick rating
  - Have students rate the lesson 1-5 with their fingers
  - Pick a couple of volunteers to explain their reasoning

Teacher Prep

https://trumpexcel.com/copy-paste-multiple-cells-excel/

	A	B	C	D	E
1	**Name**	**Current Sales**		**Name**	**Current Sales**
2	Bobby Baker	11000		Bobby Baker	11000
3	Jesse Turner	19260		Jesse Turner	19260
4	Barbara Lewis	15420		Barbara Lewis	15420
5	Melinda Milner	10130		Melinda Milner	10130
6	Fred Salas	14340			
7	Pamela Costantino	16960			
8	Jacqueline Hermann	14800			
9	Jose Perkins	10320			
10	Rosario Roy	12270			
11	Rolando Clark	14000			
12	Orlando Ellis	12440			
13	Deborah Hart	11720			

https://www.youtube.com/watch?v=TuC2huzBgjM

`

1.3: Formulas and Functions (Part 1)

Lesson Objectives

- Students will be able to understand and apply basic Excel formulas: addition, subtraction, multiplication division.
- Students will be able to understand and apply the function SUM.
- Students will learn to perform calculations, manipulate data, and automate tasks using formulas and functions in Excel.

List of Materials

- Internet
- Laptop or desktop
- Projector for teacher

Introduction

State the objectives of the lesson: to understand the purpose and syntax of basic Excel formulas addition, subtraction, multiplication division and the function SUM and use them to perform calculations.

Activity 1: Review (5 minutes)

- Have students open Excel on their computers
- Review basic spreadsheet skills such as navigating worksheets, entering data, and formatting cells
- Review how to perform simple summations
- Provide a sample dataset and have students practice applying basic formulas to perform calculations

Activity 2: Formulas and Functions Discussion (10 minutes)

- Divide class into small groups
- Provide each group with Resource 1: Excel Formulas and functions
- Instruct the groups to examine the formulas and functions carefully and discuss their purposes and usage
- Encourage groups to try to use these functions and formulas on their sample data set
- After 5-10 minutes, have groups present findings to the class
- Facilitate a discussion with the class on each formula/function and their real-world use

Question	**Answers include...**
How do you think formulas and functions in Excel can assist you in managing your household finances and budget?	• *Keep track of farming activities* • *Keep track of home expenses like electricity, water, and groceries* • ***SUM** can help calculate total expenses* • ***AVERAGE** can help budget effectively over time*

`

Can you envision a scenario where knowledge of Excel formulas could be beneficial for community projects or local initiatives?	• *Organizing a community event like a farmer's market or a fundraising drive* • *Manage budgets, track donations, and calculate profits or losses* • ***SUM** can help tallying attendance or donations*
How might Excel formulas and functions support small businesses or agricultural activities in our area?	• *Tracking crop yields, expenses, and profits* • *Helps analyze data from different crops or seasons* • *Can help organize and access information about market prices or crop varieties*
Have you ever encountered challenges in managing resources or coordinating tasks where Excel skills could have been helpful?	• *Helps create schedules, allocate resources, and track progress more efficiently* • *Streamline tasks such as budget planning and volunteer coordination*
How might Excel formulas and functions be used in local initiatives or personal projects within your community?	• *Helps organizing community meetings, managing local sports teams, or planning cultural events* • *Functions like **SUM, AVERAGE**, and **IF** could help us analyze attendance, budgeting, and scheduling for these initiatives more effectively.*

I do

- Explain the difference between formulas and functions in Excel
    - Formulas:
        - A formula is an expression that performs calculations on values in a worksheet.
        - It typically consists of mathematical operators (like +, -, *, /), cell references (such as A1, B2), constants (fixed values), and/or functions.
        - Formulas are created by users to carry out specific calculations or operations.
        - They are written by the user directly into a cell preceded by an equal sign (=).
        - Example: =A1 + B1 - 10
            - This formula adds the values in cell A1 and B1 and then subtracts 10.
    - Functions:

`

    - A function is a predefined formula that performs a specific task.
    - Functions are built-in to Excel and are designed to simplify common tasks and calculations.
    - They accept arguments (inputs) and return a result based on those inputs.
    - Functions cover a wide range of tasks, such as mathematical calculations, text manipulation, logical comparisons, and more.
    - Functions can be used on their own or as part of a larger formula.
    - Example: =SUM(A1:A10)
        - This function calculates the sum of the values in cells A1 through A10.
- Demonstrate how to create and use basic arithmetic formulas (e.g., addition, subtraction, multiplication, division)
- Demonstrate how to use the basic function SUM using a sample dataset
- Introduce common functions and their syntax
- Discuss the importance of using cell references in formulas to perform calculations dynamically

We do

- Create simple formulas and functions as a class, having each student follow along with the teacher
- Provide hands-on exercises where students can practice creating formulas and using functions in Excel

You Do

Activity 3: Formula and Function Application (15 minutes)

- Provide each student with a different dataset or scenario
- Instruct students to individually create and apply formulas and functions in Excel to solve specific problems or analyze data
- Encourage students to experiment with different formulas and functions to achieve desired results
- After completing the task, have students share their solutions with a partner and explain their reasoning

Conclusion

Activity 4: Three-Two-One (10 minutes)

- This activity serves as a formative assessment tool and allows instructors to see where students are struggling to adjust teaching accordingly
- Provide each student with a sheet of paper and writing utensils
- Have students rate the class on a scale of 1-10
- Then, have students write:
    - 3 things they learned
    - 2 ways to apply it
    - 1 question that remains unanswered
- Discuss the reflection activity and answer any questions the students have

`

Teacher Prep

- Prepare sample datasets or scenarios for hands-on exercises
- Create handouts or visual aids with examples of common Excel formulas and functions
- Review instructional videos or resources for additional support if needed

Resources

Resource 1: Excel Formulas and Functions Guide

Basic Arithmetic Formulas:

- Addition: =SUM(A1, B1)
- Subtraction: =A2 - B2
- Multiplication: =A3 * B3
- Division: =A4 / B4

Common Functions:

- SUM Function: =SUM(A1:A10)
- AVERAGE Function: =AVERAGE(B1:B5)
- MAX Function: =MAX(C1:C20)
- MIN Function: =MIN(D1:D15)
- IF Function: =IF(E1>10, "Yes", "No")
- VLOOKUP Function: =VLOOKUP(F1, A1:B10, 2, FALSE)
- CONCATENATE Function: =CONCATENATE(G1, " ", G2)

Statistical Functions:

- COUNT Function: =COUNT(A1:A100)
- COUNTIF Function: =COUNTIF(B1:B50, ">10")
- SUMIF Function: =SUMIF(C1:C30, "<50")
- AVERAGEIF Function: =AVERAGEIF(D1:D20, ">25")

Logical Functions:

- AND Function: =AND(A1>10, B1<20)
- OR Function: =OR(C1="Yes", D1="No")
- NOT Function: =NOT(E1="Pending")

Date and Time Functions:

- TODAY Function: =TODAY()
- NOW Function: =NOW()
- DATE Function: =DATE(2024, 2, 23)
- TIME Function: =TIME(9, 30, 0)

Text Functions:

- LEN Function: =LEN(F1)
- LEFT Function: =LEFT(G1, 5)
- RIGHT Function: =RIGHT(H1, 3)
- MID Function: =MID(I1, 3, 5)
- UPPER Function: =UPPER(J1)
- LOWER Function: =LOWER(K1)

Lookup and Reference Functions:

- INDEX Function: =INDEX(A1:A10, 3)
- MATCH Function: =MATCH(B1, C1:C10, 0)
- OFFSET Function: =OFFSET(D1, 2, 3)

`

- INDIRECT Function: =INDIRECT("E1")

Financial Functions:

- PMT Function: =PMT(0.05/12, 12*5, -20000)
- PV Function: =PV(0.1, 10, 2000)
- FV Function: =FV(0.06, 10, -100, -100)

`

1.4: Formulas and Functions (Part 2)

Lesson Objectives

- Students will be able to use essential Excel functions: AVERAGE, MAX, and MIN.
- Students will describe each function's purpose and applications in data analysis.
- Students will give examples on how to apply these functions to real-world scenarios.

List of Materials

- Internet
- Laptop or desktop
- Projector for teacher

Introduction

State the objectives of the lesson: to understand the purpose and syntax of AVERAGE, MAX, and MIN functions and apply them to real-world scenarios.

Activity 1: Review of Basic Excel Skills (5 minutes)

- Review how to open Excel and create new spreadsheets
- Practice basic arithmetic formulas in Excel, such as adding numbers in a column and row
- Provide a simple dataset and guide students to perform calculations using basic functions like SUM.
- Encourage independent practice and help as needed

I Do

- Review formulas from the previous lesson and review the SUM function introduced.
- Reiterate functions as predefined formulas that perform specific tasks in Excel.
- Emphasize that functions save time and effort by automating repetitive tasks and calculations.

AVERAGE Function:

- Define the AVERAGE function as a tool for calculating the arithmetic mean of a range of values
    - Syntax: =AVERAGE(number1, [number2], ...)\
- Explain that "number1", "number2", etc., are the values or cell references to be averaged.
- Example: =AVERAGE(A1:A10) calculates the average of values in cells A1 to A10.

MAX Function:

- Define the MAX function as a tool for finding the maximum value in a range of values
    - Syntax: =MAX(number1, [number2], ...)
- Explain that it works similarly to AVERAGE but returns the highest value instead.
- Example: =MAX(B1:B10) finds the highest value in cells B1 to B10.

MIN Function:

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- Define the MIN function as a tool for finding the minimum value in a range of values.
    - Syntax: =MIN(number1, [number2], ...)
- Explain that it works similarly to MAX but returns the lowest value instead
- Example: =MIN(C1:C10) finds the lowest value in cells C1 to C10

We Do

- Provide sample datasets for hands on practice following the instructor
- Guide students through applying the AVERAGE, MAX, and MIN functions to analyze the provided data
- Encourage students to actively participate in discussions and ask questions

You Do

- Present students with additional scenarios or problems where they must apply the AVERAGE, MAX, and MIN functions independently
- Pair students up in groups to work together to solve the tasks
- Review and discuss solutions together as a class
    - Highlight different approaches and strategies

Conclusion

Activity 2: Quick Rating (5 minutes)

- Ask students to rate the lesson with their fingers (1-5)
- Rating could be how well the lesson went or how well they understood the content
- Call on volunteers to explain their rating to the class
- Discuss the reflection activity and answer any questions the students have

Teacher Prep

- Practice using the SUM, AVERAGE, MAX, MIN functions
- Be familiar with how to use each of these functions and describing when they are useful
- https://www.youtube.com/watch?v=0_w0LVBQ_t4

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1.5: Graphs

Lesson Objectives

- Students will be able to create simple graphs in Google Sheets

List of Materials

- Internet
- Laptop or desktop
- Projector for teacher

Introduction

Activity 1: Review (5 minutes)

- Have students review how to open new excel sheets
- Then have students practice adding up numbers in a column and row.
    - Provide a dataset and have them add certain numbers together
- Repetition is key: try to have students complete this by themselves if they can.
- Have guiding instructions on a PowerPoint presentation to complete the summation and help students when needed.

Activity 2: Graph Types Discussion (15 minutes)

- Divide the class into small groups.
- Provide each group with a set of printed or digital materials containing various graphs from newspapers, magazines, websites, or textbooks. Ensure that the graphs cover a range of types (e.g., bar graphs, line graphs, pie charts).
- Instruct the groups to examine the graphs carefully and discuss the following questions:
    - What type of graph is it? (e.g., bar graph, line graph, pie chart)
    - What data is represented in the graph?
    - What is the main message or trend conveyed by the graph?
    - Are there any unusual or interesting features of the graph?
- After the discussion period, each group presents their findings to the class.
- Facilitate a discussion on the advantages and disadvantages of each graph type.

I do

- Explain the different types of graphs available in Google Sheets (e.g., bar graphs, line graphs, pie charts).
- Demonstrate how to create a simple bar graph using a sample data set.
- Discuss the components of a graph, including the x-axis, y-axis, title, and legend.

We do

- Create a simple graph as a class, having each student follow along with the teacher.

You Do

Activity 3: Graph Creation (15 minutes)

- Provide each student with a different data set.
- Instruct students to individually create a graph using Google Sheets that effectively represents the data provided.

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- Encourage students to experiment with different graph types and formatting options.
- After creating their graphs, have students share them with a partner and explain their choices.

Conclusion

Activity 4: Three-Two-One (10 minutes)

- This activity serves as a formative assessment tool and allows instructors to see where students are struggling to adjust teaching accordingly.
- Provide each student with a sheet of paper and writing utensils.
- Have students rate the class on a scale of 1-10.
- Then, have students write:
    - 3 things they learned
    - 2 ways to apply it
    - 1 question that remains unanswered
- Discuss the reflection activity and answer any questions the students have.

Teacher Prep Work

- Videos from lesson

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Appendix I: Biology Lesson Plan

1.1: Introduction to Plant Physiology

Learning Outcomes

- Students will be able to identify the stomata on a leaf
- Students will be able to understand the purpose of chlorophyll in plants
- Students will be able to explain the process of photosynthesis in simple terms

List of Materials

- Plant leaves
- Coffee filter
- Acetone
- Clear glass jar
- Funnel
- Flashlight (phone)
- Mortar and pestle (if needed, can use a rock to grind up leaf)

Background for Educators

Photosynthesis

Photosynthesis is the process in which plants use sunlight, water and carbon dioxide to create oxygen which then goes into the atmosphere and energy in the form of glucose. While there are many parts to this process, some of the main contributors include the stomata and chloroplasts.

Stomata

The stomata is the primary responsory for gas exchanged within a leaf and the air. At a cellular level, the stomata look like coffee beans, and they typically exchange carbon dioxide, oxygen and water.

During a gas exchange, carbon stays inside the leaf. During the day, the stomata are open while photosynthesis takes place as the sun allows for greater energy exchange through the process of photosynthesis.

Chloroplasts

Chloroplasts are small organelles inside the plant cell which store the energy of sunlight. In the membranes of the chloroplast there is a light-absorbing pigment called chlorophyll which is primarily responsible for the green color that plants emit.

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Introduction

Begin by showing the students the Plants Native to Puerto Rico. Discuss with them the plants that grow in Bucarabones. Ask students, “Think about what plants grow around the Bucarabones community. Do you know any of their names? What do they look like?” Then go into the follow up questions.

Plants Native to Puerto Rico:

Seagrape Stiff *Bristle Fern* *Golden Pathos*

Follow-up Questions:

1. “What are some similarities you can identify in all these plants?”
2. “Does anyone know how plants gain their energy?”

After giving them time to brainstorm, let them know that this activity will involve looking into how plants utilize chlorophyll to grow.

I do:

- Show them this video that explains photosynthesis: Photosynthesis Video
- Briefly explain the following terms:
    - Photosynthesis: The process plants use to make their own food
    - Chlorophyll: The pigment that absorbs the light
    - Stroma: The fluid surrounding the grana within the chloroplast

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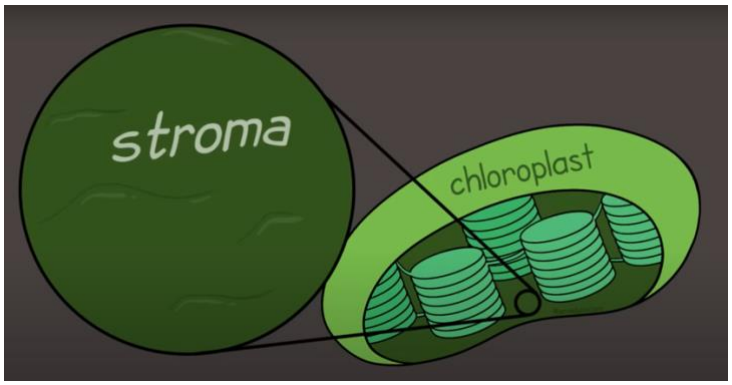
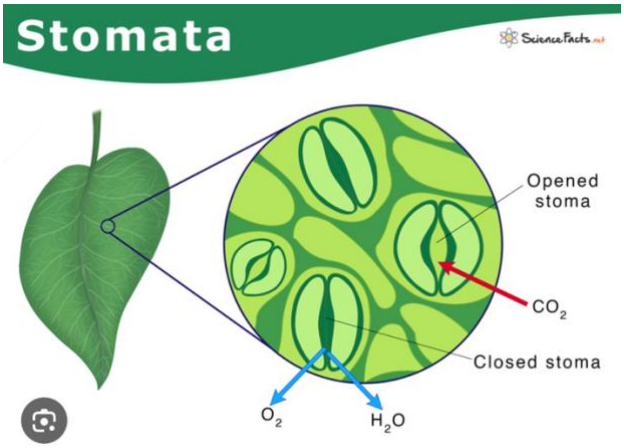


We do:

- Work together and go over the structure of a leaf, asking students to explain what the purpose of the chloroplast is
- Go over the following diagram



You do:

- Let the students know they will now be preforming an experiment to do a simple chlorophyll extraction from a leaf

Instructions:

1. Gather all materials needed.
2. Make sure to do this experiment in a ventilated space.
3. Grind the leaf using a mortar and pestle or a rock if necessary. The product should be a paste-like substance.
4. Pour the paste into a jar and soak it in 15 milliliters (or until the paste is completely submerged) of acetone for 15 minutes.

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5. Place a funnel on top of a second jar.
6. Put a coffee filter over the funnel.
7. Pour the acetone/paste mixture into the coffee filter.
8. Collect and observe the mixture that comes from the coffee filter.

When the experiment is completed, they should have a clear green liquid in the jar. All other materials can be thrown away. When you darken the room, then shine a light into the jar. The light energy will cause the extract to fluoresce due to the extracted chlorophylls.

If need be, this link shows the fluorescence from the chlorophyll in the dark: Chlorophyll Fluorescence UV

Conclusion:

As a class, have students bring up their extracted chlorophyll and show the class. Then, ask them the following questions in the table below, encouraging them to take educated guesses.

After allowing them time to think and discuss, reveal to them the following results.

Questions	Answers/Results
"Why did the chlorophyll glow?"	*"When the chlorophyll is removed from the plant, it still absorbs light. However, because it is removed from the photosynthesis process, the absorbed energy light has nowhere to go which results in a red glow. "* *For more information: Chlorophyll Fluoresence Article*
"Why does chlorophyll glow, but not the leaves?"	*"When the chlorophyll is actively being used in photosynthesis, the absorbed light is inducing cellular respiration, the process of plants using energy from the sun."* *For more information: Green Plants, Red Glow Article*
"What is the purpose of chlorophyll in photosynthesis?"	*"The function of chlorophyll is the convert the light energy of the sun, as well as water and carbon dioxide to produce glucose and oxygen."* *For more information: Chlorophyll Article*

Bonus Activities

- Online Photosynthesis simulation: Link

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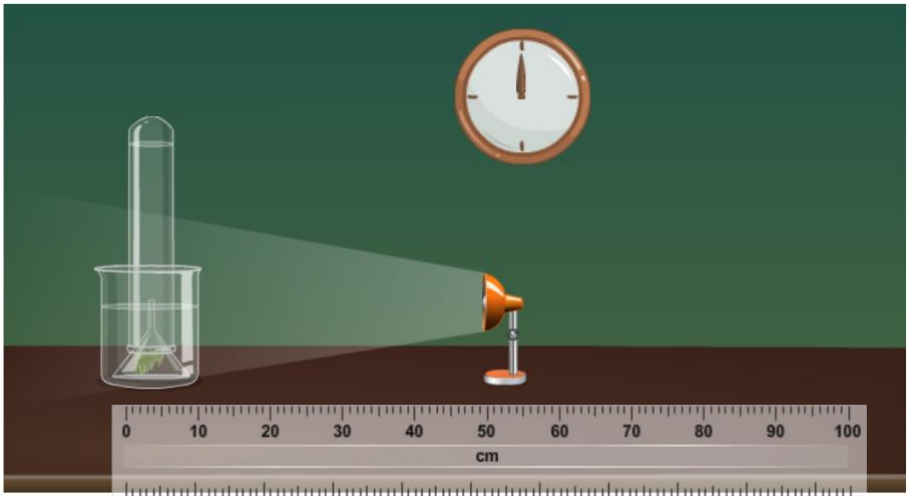
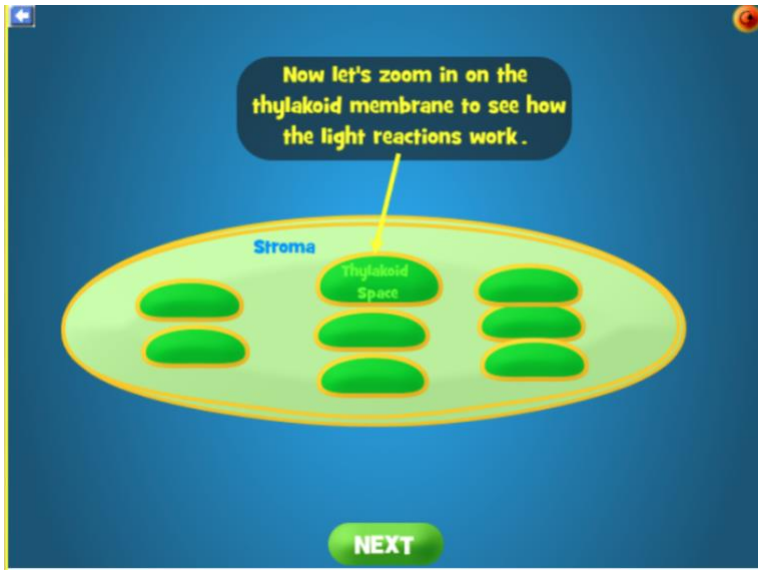
- Allows students to manipulate light intensity, light color and distance from a light source directly onto a plant.
- Students can measure the rate of photosynthesis over time through the oxygen production shown through bubbles in a beaker. ‘



- Interactive cellular respiration simulation: Link



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1.2: Introduction to Animal Physiology

Lesson Objectives

- Students will be able to define a habitat
- Students will be able to describe at least two different habitats
- Students will be able to explain how habitats support animals' various needs

List of Materials

- A shoebox or plastic container
- Natural materials such as rocks, leaves, grass etc.
- Art materials such as paint, paintbrushes, clay etc.
- Tape
- Scissors
- Glue

Background for Educators

Our planet hosts a diverse array of millions of species, encompassing both animals and plants. While some species, like humans and many mammals, thrive on land, others, such as fish, find their preferred habitat in water. Each species seeks out areas that offer the necessary resources for their survival. This specific environmental space is termed a habitat, serving as the natural home for a particular animal or plant species. Within their habitats, these organisms find everything essential for their sustenance, growth, and reproduction, including food, water, air, and shelter for protection.

The characteristics of habitats can be defined by various factors, ranging from physical attributes like climate, soil type, and rainfall to biological elements such as the availability of food sources and the presence or absence of predators. Habitat requirements vary among different species; some are generalists, adapting easily to a broad range of environments, while others are specialists, thriving exclusively in specific types of surroundings.

Introduction

Begin by introducing this paragraph to your students:

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“Welcome, students, to an exciting exploration of the intricate tapestry of life on our planet! In this lesson, we will delve into the fascinating world of habitats and the diverse species that call them home. Our Earth is teeming with millions of unique organisms, ranging from the majestic animals roaming on land to the enchanting plants rooted in the soil. Just like us humans, each species has its preferred habitat, a special place that provides the essential resources needed for survival, growth, and reproduction.

Throughout our journey, we will uncover the secrets of these habitats, understanding the crucial role they play in shaping the lives of various animals and plants. From the bustling ecosystems on land to the serene environments beneath the water's surface, we will explore how different species adapt to their surroundings. Join us as we unravel the factors that define habitats, considering both the physical characteristics such as climate and soil type, as well as the biological elements like food sources and the presence of predators.

Get ready to embark on a learning adventure where we discover why some species are versatile, thriving in diverse habitats, while others are specialists, perfectly suited to specific environments. By the end of this lesson, you'll gain a deeper appreciation for the intricate relationships between organisms and their habitats, recognizing the vital role these ecosystems play in sustaining life on Earth. Let's embark on this exciting journey of discovery together”

Then ask them the following questions:

- “Does anybody know what a habitat is?”
- “Can anyone think of any habitats that you know of?”
- “Can you think of any animals that might live in these habitats?”

Allow them to then turn and talk to their peers and allow for follow-up questions to be asked.

I do:

Begin with showing your students the following image:

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Ask them the following questions:

- "What kind of animals do you think live in each of these habitats?
- "Why do you think certain animals can live in some habitats but not others?

We Do:
Then ask them to brainstorm the habitat elements that should be considered when creating one. After they've had time to brainstorm, show them the following list of elements they should consider.

- Vegetation/plants
  - Bare
  - Lush
  - Green
  - Trees
  - Bushes
  - grass
- Type of ground
  - Soil
  - Sand
  - Ice
  - Rock
- Ground profile
  - Flat
  - Hilly
  - steep mountains
- Food source
  - Fruits
  - Vegetables
  - Grass
  - Trees
  - Other animals
- Water availability
  - Ponds
  - Rainfall
- Shelter

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        - rock crevasses
        - Bushes
        - large trees
        - Burrows
        - Nests
    - Animals that live in the same habitat
    - Other features
        - trees or rocks for climbing
        - water for swimming
    - Color of things
        - brown/yellow/green grass
        - red/brown/yellow sand

We do:

1. Let the students know they will be creating their own habitats now. Before they start building, ask the students what kind of habitat they want to build. Then ask them the following questions:
    - "What kind of animal are you building this habitat for?"
    - "What does this animal need to survive in your habitat?"
2. Show students the materials they have available for their habitats and give each student a habitat box. At this point you can also take your students outside to collect any natural materials they may need for their habitats.
3. Then explain that each habitat needs to include things that the animal they chose needs to survive. Describe the materials and how students can use them.
4. Give the students about 40-45 minutes to build their habitat with the materials. Check in and walk around your groups.

Conclusion:

When students have finished their habitat models, have students present them to the rest of the class. Guide each group's presentation and ask:

- "What animal did you build your habitat for?"
- "What type of habitat did you make for your animal?"
- "Tell us why you chose that habitat"
- "Can you describe your habitat?"

Then start a discussion with the class. Let students share their thoughts and use their replies to point out that different animals have different needs. Conclude the activity by having students summarize what they did and what they learned about animals and their habitats.

Bonus Activities:

- Make a Miniature Habitat quiz: Link to pdf
    - Allow students to take this "quiz" individually and then have them share their answers with their peers.

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1.3: Introduction to Genetics

Lesson Objectives

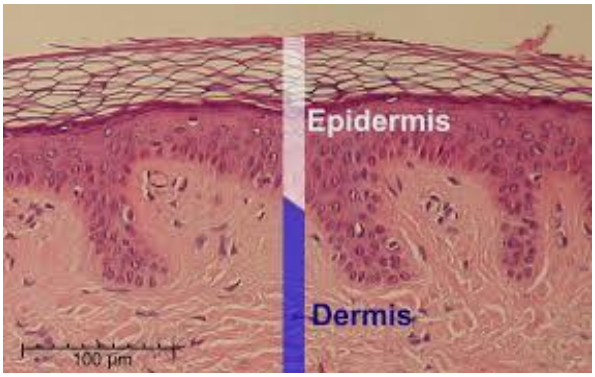
- Students will be able to define genetics
- Students will be able to describe the purpose of DNA
- Students will be able to explain what it means to be biologically related

List of Materials

- Paper towel
- White printer paper
- Pencil
- Clear tape
- Scissors
- White paper
- Sibling pairs of students
- Unrelated pairs of students

Background for Educators

Gestation
The process of period of developing inside the womb between conception and birth
Epidermis
The surface of the skin that overlies the dermis



DNA
DNA stands for deoxyribonucleic acid. A self-replicating material that is present in nearly all living organisms as the main building block of chromosomes. It is the carrier of genetic information. It consists of four building blocks, adenine, thymine, cytosine and guanine. It is all held together by a phosphate backbone.

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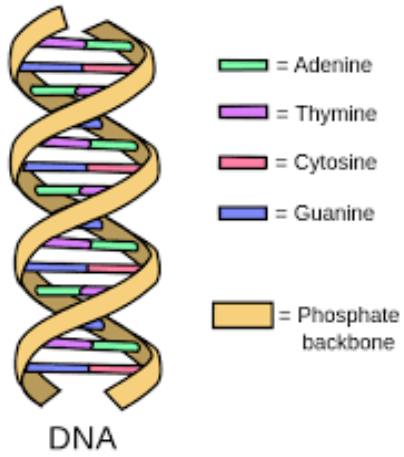
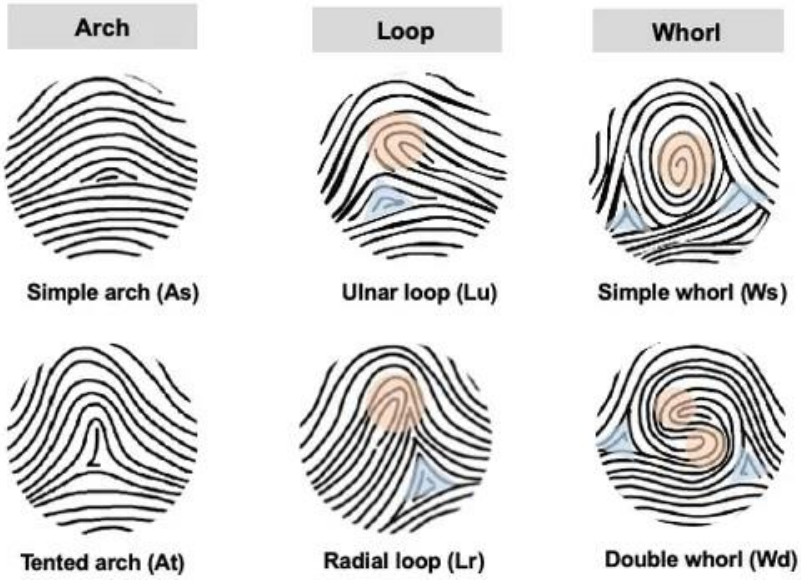


Fingerprint Patterns

DNA influences our fingertips, but fingerprints are unique because of the special folding pattern of the tiny ridges in our skin. This occurs during fetal development. No two fingerprints are alike except those of identical twins.



Inheritance

Inheritance is the process of transmission of genes from parent to offspring.

Genetics

The study of heredity and the variation of inherited characteristics.

Introduction

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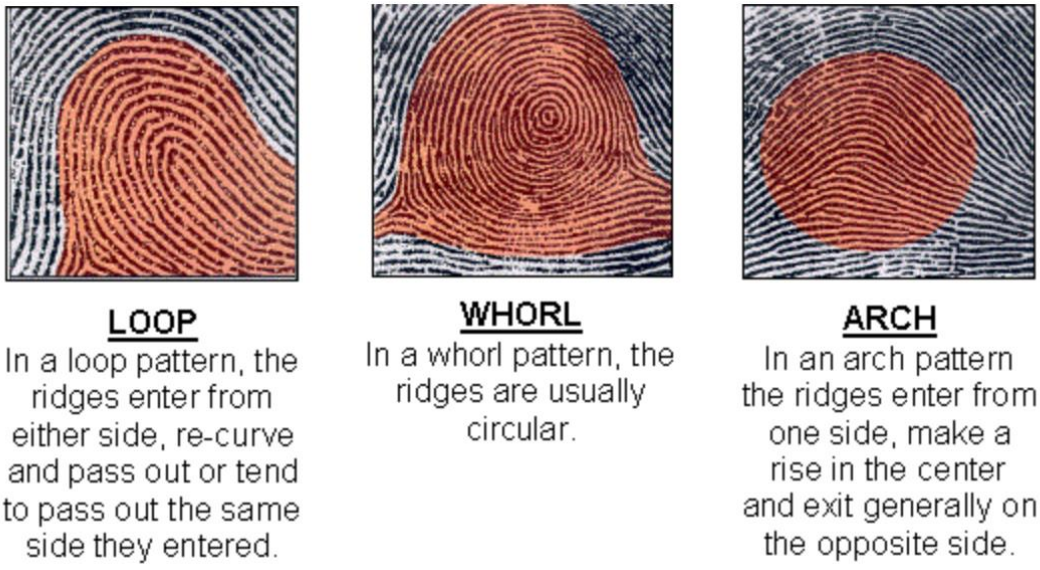
Today we will be learning about fingerprint development and how it relates to DNA. Between weeks 10 and 24 of gestation, a process occurs within the mother's womb which shapes the outermost layer of skin on fingerprint. This transformation leads to the formation of unique patterns we recognize as fingerprints.

These fingerprints, once established during gestation, remain static and endure throughout an individual's life. While the pattern adapts in size as the person grows, the fundamental shape remains unaltered. To better grasp this concept, imagine modeling the change in size by inking your own fingerprint onto a balloon and then inflating it.

The permanence and distinctiveness of fingerprints make them invaluable for identification purposes. Law enforcement, for instance, relies on fingerprints to ascertain an individual's presence at a crime scene. Despite the variability in the exact number, shape, and spacing of ridges among individuals, fingerprints can be broadly classified into three categories: loop, arch, and whorl

As we delve into today's lesson, we will explore the intricacies of fetal fingerprint development and the lasting impact these patterns have on identification methods. Get ready for an engaging journey into the world of fingerprints!



The DNA that everyone inherits from their parents determines many personal characteristics of the person. We can often tell that two people are siblings because they seem to have similar physical traits. Therefore, if DNA determines fingerprint patterns, then siblings are more likely to share the same fingerprint category.

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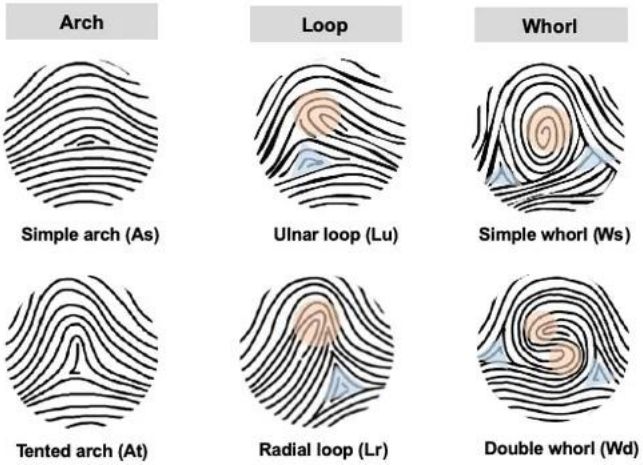
I do:

Begin by showing your students different types of fingerprints as seen below:



Ask them to look at their own fingers and determine which patterns they have. Follow by showing them the video linked here: Link to DNA Fingerprinting

Ask them the following questions:

- "What does it mean to be biologically related?"
- "What are fingerprints and how are they formed?"

We do:

Start the science project by discussing which fingerprint patterns everyone has and how they determined it. If there are any siblings in the group, compare their fingerprints and determine any similarities found within them.

You do:

Begin by telling your students they will be completing a fingerprint DNA experiment.

1. Rub a pencil on a piece of printer paper.
2. Using a clean finger, press and slide the finger over the pencil mark.
3. Then roll the grey fingertip onto the sticky side of a piece of clear tape.
4. Cut the piece of tape and stick it onto a piece of white paper.
5. Continue this until there is a clear fingerprint.

Once every student has a clear fingerprint, make sure to write their names next to the marking. Then show the class and ask them to observe everyone's fingerprints.

Conclusion:

Ask the following questions to your students:

- "Can anyone determine the shape of their fingerprints?"
- "If there are siblings in the room, can anyone see any similarities in their fingerprints?"
- "Are there some patterns that are more common than others?"

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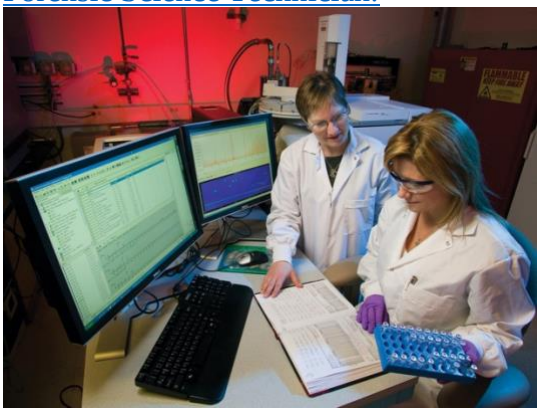
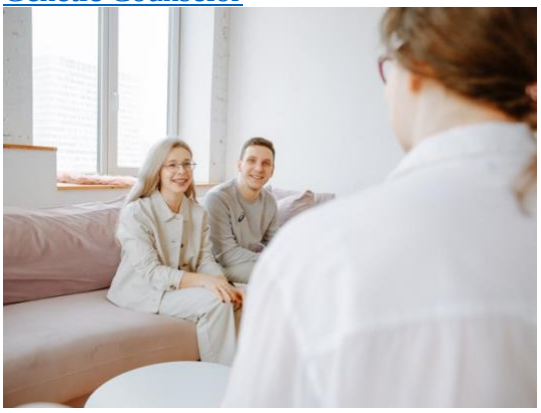
Bonus Activities:

Careers to explore:
The following gives a list of careers that students may want to look into if they are interested in genetics.

Forensic Science Technician:



Genetic Counselor



Cytogenetic Technologist

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