Designing an Online Learning Facility for Panama Fundesteam

Photo Courtesy of: Fundesteam, 2018

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Designing an Online Learning Facility for Panama Fundesteam

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Abstract

Panama's severely outdated education system currently perpetuates a disparity among its citizens, especially those living in poverty. To rectify this problem, the Fundesteam organization created STEAM education robotics programs to promote high-paying STEAM careers for Panamanian school children. However, the current COVID-19 pandemic is severely limiting Fundesteam's robotics programs and Panamanian youth education. The goal of this project is a two-fold response to this limitation. The first phase of this project will be the development of a set of guidelines with information about the structure and available resources to aid in creation of online learning content. The second phase of this project will be a set of recommendations for the creation of a combined online learning and makerspace facility in Panama City. The focus of this project is to assist Fundesteam in designing a facility to produce educational content for virtual learning which can reach Panamanians currently without access to STEAM education. The project investigates virtual learning and makerspace facilities and includes recommendations for equipment that Fundesteam educators may use to aid in the creation of online learning content.

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Chapter 1: Introduction

Following the construction of the Panama Canal, Panama developed a flourishing economy through shipping activities, relationships with international companies, and growth of the Panamanian trade industry. Due to the growth of financial services and increased trading power with the completion of the canal, Panama observed a doubled increase of income per capita between 2004 to 2014 (Hausmann, Espinoza, Santos, 2017). Insufficient educational opportunities in Panama yield a shortage of skilled workers which puts the country's economic future at risk. In comparison to other Central American countries, Panama has a relatively good economic situation, but the reform in their education system has been slow.

The educational system that the Panamanian government established is known as "one of the worst in the world". Despite major advances in technology, the Panamanian educational system has resisted reform for 30 years (Scholaro, 2018). For Panamanian children, the government mandates six years of primary education and three years of middle school education. The quality of teaching is significantly lower in rural areas because many families rely on the income from children laboring in the fields (Scholaro, 2018). Panama's minister of education began to improve the quality of secondary education across the country by introducing new technology in hope that more Panamanian children will have a head start in life. Approximately 87 percent of the students in Panama enroll in the public education system, but the dropout rates in the education system are high (Lee, 2016). As of 2013 the observed dropout rate for primary education was 14 percent which doubled from 6.8 percent in 2012 (Knoema, 2013). The increase in dropout rates is occurring mainly in rural areas, but attendance rates in urban areas are not significantly better.

Most primary and middle school education focuses more on the humanities aspect of learning. For Panamanian students continuing on to the secondary level of education, the curriculum is split into either a vocational or academic enhancement pathway (Lee, 2016). It is not until later in life that many Panamanian children get to experience anything outside of the basic humanities education. As completion of the education system in Panama does not guarantee a skilled labor position, the current situation provides little motivation to continue further on the current educational path (Lee, 2016).

Panama has a large gap in Science, Technology, Engineering, Art, and Math (STEAM) education in comparison to countries of the first world, but in 2014, STEM (Science, Technology, Engineering, and Math) education in Panama became a reality. PanamaSTEM started off slowly by implementing an after school hands-on learning program taught by Lorena Degracia, a certified robotics teacher in the LEGO Education program (PanamaSTEM, 2020). After many news outlets documented the new after-school robotics initiative, the program received a highly positive response. PanamaSTEM decided to expand and create an extracurricular learning center in Ciudad del Saber in conjunction with Marvin Castillo of Fundesteam (PanamaSTEM, 2020).

Fundesteam is a non-profit organization which promotes development of STEAM education in Panama. Their hope is that introducing collaboration, innovation, and problem-solving techniques into Panamanian education will change the lives of thousands and break the cycle of poverty for the future of their country (Fundesteam, 2020). Their goal is to improve the resources available to lower-income children, such that they are able to gain a more modern education and increase complex skills to then transition into well-paying career opportunities. By developing an educational path that is more likely to lead to modern complex careers,

Fundesteam hopes to address the issue of inequality of poverty in Panama. The Fundesteam organization recognizes the issue within the social structure of Panamanians: those born into poverty never experience an opportunity to escape that fate by never receiving the resources or knowledge to improve opportunities within their lives. Fundesteam wants to change this situation by providing easier access for low-income families to study STEAM fields (Fundesteam, 2020).

To this end, Fundesteam plans to assist teachers in Panama City by creating a communal learning facility. This communal facility will include various resources for educators to record and upload online STEAM content and lessons for Panamanian children. While this facility will contain multiple media studios for online learning, it will also contain a makerspace for STEAM educational projects. Our project will involve researching online and makerspace education to create a set of recommendations for the design of this facility. In addition, Fundesteam wants to provide manuals to at-home educators who cannot travel to the facility to create online learning content. This manual will provide guidelines on how to create online content, how to set up an at-home studio, and recommendations for recording equipment. This project will also focus on research and writing these guidelines. With this common facility and home guidelines for educators, Fundesteam can drastically improve the STEAM education for Panamanian children.

Chapter 2: Background/Literature Review

This chapter discusses STEAM education, Panama's education system, Fundesteam and the work they are doing to improve Panamanian STEAM education. The last two sections of the chapter examine the benefits of implementing virtual learning and makerspaces.

STEAM Education

2.1 The Importance of STEAM Education

STEAM education is typically defined as the preparation of students in skills and competencies that fulfill five subjects (Science, Technology, Engineering, Art, and Math). A successful STEAM education takes the concepts and builds on to one another enabling students to utilize the resultant knowledge for real-life applications (Eberle, 2010). A STEAM education program cultivates children with good critical thinking skills, a higher proficiency in science literacy, and enables a younger generation of innovators (All Education Schools, 2018). STEAM strives to strengthen the foundation of STEM by enhancing students' critical thinking skills and promoting awareness of the intersection between art and liberal arts in conjunction with art, science, technology, engineering, and math. A STEAM education program provides students with methods to create new strategies for problem-solving, analyzing data, innovation, and brings together multiple fields for a cohesive education (All Education Schools, 2018.).

With this sense of innovation, educators are developing younger generations that can produce new products and processes that sustain the economy. As STEAM field occupations dominate the list of fastest growing occupations according to the U.S. Department of Labor (All Education Schools, 2018), many jobs in the future will require a basic understanding of math and science. Figure 2.1 depicts the U.S. Bureau of Labor's projected growth rate of STEM occupations from 2014 to 2024. The figure predicts that Mathematical Science occupations,

STEM-related postsecondary teachers, and computer occupations will dominate the list of growth rates for the upcoming years (Fayer, Lancer, Watson, 2017). As shown in the figure, it is crucial for younger generations to be exposed to STEAM learning to ensure a higher possibility of success in the workforce later in life. STEAM education seeks to integrate technical principles to create a more holistic understanding of the world while providing more knowledge on how to pursue a career in more innovative fields in the workforce.

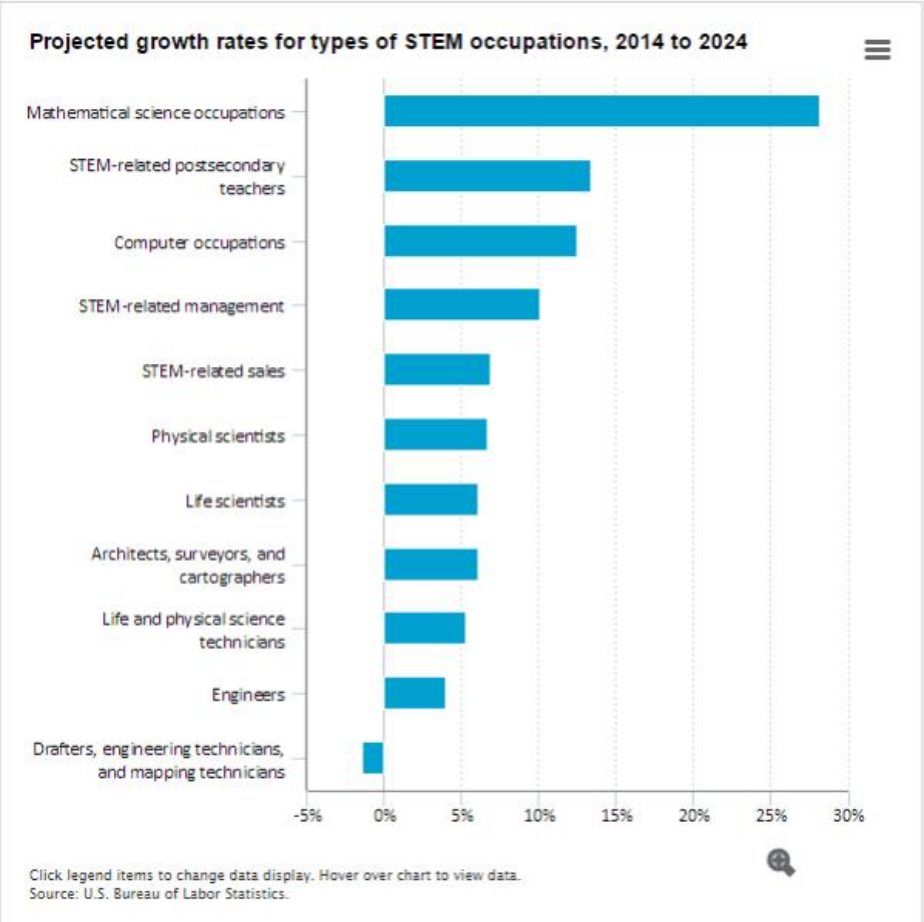

Figure 2.1: Projected Growth Rate for STEM occupations between the years of 2014 to 2024 from the U.S. Bureau of Labor Statistics (All Education Schools, 2018.)

2.2 STEAM Education in the United States

In the United States, education researchers recognize that the world is forever changing and becoming more complex. There is the belief that the nation's youth should attain knowledge and skills that will enable them to solve problems, evaluate given evidence, and come to logical conclusions. The US educational system aims to develop future workers, neighbors, and leaders among the children in the nation. The educational system engenders youth with the ability to solve more complex challenges of the real world and meet any potential demands of an evolving workforce (Committee on STEM Education and National Science and Technology Council, 2018). Additionally, the educational system in the United States strives to make sure that "no child is left behind"; such that no matter where they live, children still have access to a quality learning environment in which they could gain STEM fluency (Committee on STEM Education and National Science and Technology Council, 2018).

In December of 2018 the United States put the "North Star" Plan, a federal strategy, in place for the upcoming five years to foster a future where all Americans have access to high-quality STEM education and that the country would soon be the global leader in STEM literacy and employment (Committee on STEM Education and National Science and Technology Council, 2018). The "North Star" Plan pursued three goals: 1) build strong foundations for STEM literacy; 2) increase diversity, equity and inclusion in STEM; 3) prepare the STEM workforce for the future. This "North Star" Plan was incorporated into the US educational system to ensure every American receives the opportunity to master STEM concepts and yield a STEM-literate public more equipped to understand rapid changes in a technological-driven environment (US Department of Education, 2020). The United States set a goal to provide STEM education to students who are historically underserved or underrepresented. The US

strives to build a stronger educational foundation so that underserved and underrepresented children receive the same access to high-quality education and also equality within STEM field employment. The "North Star" Plan also strives to bring unique learning experiences regardless of a vocational or college-educated pathway and prepare and encourage learners to pursue careers in the STEM field (Andre, Durksen, & Volman, 2016).

This federal strategy includes four components to represent a cross-cutting set of approaches to implement federal actions needed to achieve the goal of this program. The four elements of this plan are: 1) develop and enrich strategic partnerships; 2) engage students where disciplines converge; 3) build computational literacy; and 4) operate with transparency and accountability (Andre, Durksen, & Volman, 2016). The US Government hopes to improve the interpersonal connections of educational institutions, communities, and employers to bring an array of resources to strengthen STEM education within the nation. The government believes establishing community and resources will facilitate educators adding meaningful and real-life experiences into the curriculum. This enables instructors to engage and inspire more students while introducing new digital devices and technology that have transformed our ever-changing society. The program also calls for the Federal Government to open evidence-based, decision-making, and more complex STEM programs, activities, and investments (Andre, Durksen, & Volman, 2016). With the four key components, they hope there is more potential to empower employers, educators, and communities for the benefit of all learners at any level. President Trump's administration invested nearly $540 million into supporting Science, Technology, Engineering, and Mathematics education in November 2019 (Committee on STEM Education and National Science and Technology Council, 2018).

2.3 STEAM Education in Panama

The educational system in Panama is one of the most poorly performing in the world after 30 years with little to no reform (Scholaro, 2018). As children progress through the educational system in Panama, their classroom education focuses more on the humanities subject matter rather than STEAM-based subjects. The maintenance of the outdated curriculum mainly focuses on the structural issues found within the educational system. Attempts to change curriculum tend to start disputes between employed and unionized educators and the Federal Government which yield gridlock. This roadblock prevents any necessary educational reform from taking place (Scholaro, 2018). Furthermore, these disagreements cause a divide between the public and private educational institutions. Private educational institutions are able to freely reform the education style within their institutions without interference from the government. This gives students enrolled in private education "a head-start in life" (Lee, 2016). Within basic Panamanian life a STEAM educational curriculum is relatively non-existent. The incorporation of guidelines for at-home educators and the addition of a common studio facility for educators will increase the availability and quality of online STEAM curriculum for Panamanian children.

2.4 Fundesteam

Origin and Mission

In 2014, the first group of Panamanian school children attended the World Robotics Olympics competition held in Sochi, Russia. The delegation finished second to last out of 65 participating countries across the world, including over 70,000 children. This defeat motivated the creation of Fundesteam (Fundesteam, 2020).

Panamanian children born into low-income families rarely receive the opportunities necessary to escape poverty and this perpetuates a cycle of desperation. Fundesteam's goal is to

structure the implementation of STEAM education into Panamanian public schools to develop the skills necessary for high-paying careers and reducing poverty. Fundesteam is aware of the need for different school communities and uses their yearly benefactors to help expand these education programs. Local teachers learn robotics and receive materials to help conduct classes on the subject in their communities. As shown in the figure below Fundesteam distributes a large amount of LEGO robotics kits to aid teachers in creating robotics programs for their schools. The robotics program creates a self-sustaining cycle of knowledge for children in those communities (Fundesteam, 2020).

Figure 2.2: Marvin Castillo CEO of Fundesteam representing Fundesteam as they donate LEGO robotics kits to a Panamanian School (Fundesteam, 2018.)

As of 2020, Fundesteam has helped over a thousand students compete in national level robotics competitions through school outreach robotics education programs. Through Fundesteam's program, over sixty students have competed at the international level for robotics competitions within the past six years. A survey conducted by the Pan American Development

Fund of over 1600 participating students indicated that 90 percent of participants were motivated to go to college after engaging in these programs (Fundesteam, 2020).

2.5 Virtual Learning

Virtual learning (or online learning or "e-learning") is a method where teachers conduct lessons remotely as opposed to a classroom setting. It is one of the newest and most popular forms of distance learning; and within the past decade, virtual learning has made a major impact on post-secondary education (Stern, n.d). Teachers and professionals alike upload online versions of their regular classroom offerings and provide as much or as little extra help as they see necessary. Online learning has continuously matured as availability of software and personal technology has evolved. Over the past two decades, there has been a steady rise in Massive Open Online Classes (MOOC) among premiere universities across the globe, such as Massachusetts Institute of Technology, Harvard University, Indian Institute of Management, and Oteima University in Panama (Chanda & Ghosh, 2020).

With the maturity of technology, online content has become readily available and easier for teaching professionals to accommodate distance learning. With technology advancing, Course Management Systems like Blackboard, Canvas, and WebCT enable instructors to easily design and deliver online content for their courses with a flexible framework. These services permit teaching professionals to create postings, schedules for deadlines, forums for announcements to communicate information immediately to all students, discussion boards to support asynchronous discussions and questions for instruction, modules to publish and view course content in easy to follow sections, and specified areas for assignments, tests, and quizzes that easily update gradebook postings (Stern, n.d.).

Advances in technology allow virtual learning to take two different forms. Instructors can upload live lecture content or choose to do the opposite with “asynchronous” learning in which instructors upload pre-recorded content. Live instruction, or “synchronous” learning, provides both the instructor and the student with regular check-ins and ensures students stay current with instruction. Asynchronous learning makes students responsible for keeping up to date on content and grants flexibility to at-home lifestyles. With the 2020 worldwide Pandemic of COVID-19, many universities, schools, and colleges moved to online learning to create a safe environment for faculty and students during an unprecedented time. The social changes that came with the COVID-19 pandemic generated new opportunities to create a stronger education for those who normally might not be able to receive one.

Virtual learning offers the opportunity for students across the globe to access the same class content simultaneously. Implementing concepts like remote learning in the future opens up the opportunity for universities and schools alike to bring more online content to students worldwide. Before this change many post-secondary institutions who have previously taken part in online education have been cautious in their offerings and limited the scope to more short-term/part-time courses which catered to working professionals (Chanda & Ghosh, 2020). During this pandemic, instructors from many colleges, universities and schools across the globe were asked to make all types of content available to their students, including labs and courses that students would normally complete through hands-on instruction.

The 2020 pandemic compelled higher education institutions to branch out and explore using online learning to extend course availability remotely to students. The switch to online courses made individuals consider how to design more accessible courses for instruction. After

using virtual learning during the COVID-19 pandemic, the possibility of expansion in availability and accessibility of this style of learning became more feasible for the near future.

Virtual learning comes with benefits and challenges. It is a difficult adjustment for students and teachers, but once fully adapted it offers many benefits. Fortunately, with the idea of online learning, instructors can educate numerous students simultaneously. In addition, online learning addresses the needs of students who might not be able to or chose not to participate in a traditional classroom setting. This method aids students who cannot attend traditional settings, who live in remote locations, who cannot find the specific content at their particular school, or who just prefer to work independently to receive the benefits of a well-versed education (Stern, n.d.). Online learning students determine the amount of their involvement, the time they choose to learn, and the location where they participate. To have a successful experience with online learning, students should meet three basic requirements: have access to a computer or similar technology; have access to the Internet; and have basic motivation to succeed in a non-traditional classroom setting. Course environments like these are highly beneficial for those who need to fit education into busy schedules. Through asynchronous learning, students have the flexibility to complete lectures, requirements, and assignments at their leisure. Students are able to fuse work and education into life.

Individuals may encounter challenging issues when dealing with virtual learning, whether it is instructors adapting content to an online format or students managing to successfully complete an instructor's online curriculum. Problems can occur for both students and teachers including committing the additional time to adapt when moving from a traditional setting to a virtual classroom. Along with transitioning between the two environments, it is fairly common for students and instructors to experience technical issues. Many people may not have access to

high bandwidth or a reliable Internet connection needed to complete online courses (Kumar, 2015). These obstacles can make it difficult for both parties, whether uploading or attempting to receive classroom content. Others may even have issues at home with their devices; older computer models may make it more difficult to view a course management system or may not meet appropriate technical requirements.

Students' challenges differ from those of instructors when completing online learning content. To successfully navigate through an online course, students have to maintain time management, self-motivation, and good computer literacy. Without these one may see a decrease in performance from students. Computer literacy is an important skill for a student's success in online learning. To participate a student needs to know how to log in, engage in classes, submit work, and communicate with instructors and classmates to ensure success in the course (Purdue University Global, 2019). Online courses demand time and intense work and the courses are seen as more difficult. Without self-motivation, individuals begin to lose their sense of discipline and time management skills. If students do not stay engaged, complete tasks, and make progress, they will fall behind and their actions may result in a negative outcome (Purdue University Global, 2019). When completing online learning, most students take their courses from their residence which provides a comfortable environment that may be more tempting for procrastination and straying from work that they need complete. Any or all of these behaviors can cause a student to fall behind and eventually drop a course.

Teachers also have their own unique set of challenges when it comes to producing online-learning content. Some educators can be technically challenged. To ensure success for both parties, educators must be able to manage basic programs, and navigate through fixing issues (Kumar, 2015). Along with technical challenges, educators may have limited access to

technology when teaching from home causing lower quality of online content (i.e. poor audio and visuals) which may be disruptive for the student. Technical challenges can prohibit instructors from delivering the best possible online education content to students.

To continue enhancing online education experiences for students, educators need to be creative in finding supplements to accommodate their normal classroom styles. Due to the nature of online learning, the majority of course content is completed by students from home. Since students may have difficulty focusing in a more comfortable environment, educators face the challenge of producing more engaging content. Creative educators can foster a sense of comradery within the online experience, and alleviate some of the discomfort for those students who dislike the lack of community that comes with online learning.

There are many benefits and challenges that come along with the new innovation of online learning. With some creative thinking and logical reasoning educators and students can prevent challenges faced when participating in online learning and the benefits both parties receive can be strengthened. With innovative approaches to releasing content, educators can help engage their students, foster a sense of community, and strengthen their students personal skills. The addition of Fundesteam's common facility will supply teachers with resources needed to create high-quality content, aid in implementing engaging education, and most importantly, reap benefits for both educators and students.

2.6 Makerspaces

2.6.1 What is a Makerspace?

A makerspace (also known as a hackerspace) is a collaborative workspace facility for D.I.Y. (Do It Yourself) project work containing community-shared tools, machinery, art supplies, and technology for artists, engineers, programmers, educators, and creators. A

centralized theme for makerspaces involves cooperation among the local community to teach and learn technical skills involved with STEAM fields (Makerspaces, 2017). The skills and resources involved vary among different makerspaces. For instance, the Technocopia Makerspace in Worcester, MA, contains many different metalworking and woodworking tools, as well as community members who teach others how to use this machinery (Technocopia, 2013). On the other hand, the Worcshop in Worcester, MA, offers machining tools, Computer Numeric Controlled (CNC) Routers, and training for this equipment (The Worcshop, 2019).

Figure 2.3: Technocopia Youth Screen-Printing Class (Technocopia, 2013)

2.6.2 Why are Makerspaces important?

The two main benefits of a makerspace for a local community involves sharing resources and knowledge (Calgary Economic Development, 2016). By sharing resources, a makerspace facility might house expensive equipment for use by multiple members, which are likely too costly for each individual consumer. For example, a PS48 Pro series Laser Cutter retails for approximately $10,000 (Full Spectrum Laser, 2020), yet a member at the Technocopia Makerspace in Worcester could use this machinery at the cost of a membership fee (e.g $75+) and materials. By lowering the cost necessary for individual projects, makerspaces become an invaluable resource for small-time creators and entrepreneurs. With lower costs for production,

entrepreneurs can compete economically with larger scale businesses by producing typical artisanal products which are more valuable (Calgary Economic Development, 2016).

Figure 2.4: A PS48 Pro Series Laser Cutter located at Technocopia (Technocopia, 2013)

The second benefit, a sharing of knowledge, directly relates to the proliferation of STEAM education commonly found in makerspaces. The skills involved in designing, machining, fabricating, and implementing personal projects directly correlate to similar skills found in STEAM fields. The co-operative nature of makerspaces predicates that STEAM skills are often taught at very little to no monetary cost to the student, provided the student maintains the social contract of reciprocity that assumes equally teaching others their own personal fabrication skills. This exchange reverts to a traditional barter of skills and knowledge between members, rather than depending on monetary cost. Employing this concept can remove certain financial barriers that prevent individuals from becoming experienced in these skills (Calgary Economic Development, 2016).

These benefits are largely impactful and have led to considerable growth in the number of makerspaces since their inception in 2006. As of April 2020, there are 1297 active makerspaces and 355 planned makerspaces registered with the Hackerspace website forum (Hackerspaces, 2020).

2.6.3 How do Makerspaces promote STEAM Education?

A University of Washington and University of Maine joint study found a six percent increase in exam scores for students participating in active learning courses, as compared to the traditional classroom setting (Freeman et al., 2014). Active learning implies using instructional methods which engage the student directly in the learning process. This engagement depends heavily on the input of the student and their participation in specific collaborative activities. This study predicted students were 1.5 times as likely to fail a course based on traditional lectures compared to an active learning environment (Freeman et al., 2014). A traditional classroom setting provides ample opportunity for auditory and visual style learning. An active learning environment includes both those learning styles, but additionally allows for kinesthetic type learning. However, providing this active learning environment is difficult to do in the functional space of a traditional classroom setting. Traditional classroom settings, centered around viewing lectures, require individualized workspaces for note-taking and written work.

The conversion of traditional settings into active learning environments would require adapting existing spaces into efficient convertible areas. Instead, STEAM educators focusing on active learning can use makerspaces because these settings are conducive to an engaging environment. The benefits of this environment depends on student involvement with collaborative activities. Makerspaces, acting as a communal workspace, can serve as a location for students to participate in joint STEAM projects (Blackley et al., 2017).

The conjunction of STEAM education with makerspaces is a well-practiced concept. At Worcester Polytechnic Institute (WPI), the Foisie Innovation Studios makerspace provides 3-D printers, fabrication tools, and materials for engineering students to design and create engineering projects for their coursework (Worcester Polytechnic Institute, 2019). For example,

robotics engineering students have coursework dependent on the creation of robotics software and hardware which must perform various tasks. The Foisie Innovation Studios makerspace supports a robotics lab for this purpose, containing all the necessary materials and equipment for robotics engineers to complete their academic projects.

Figure 2.5: Robotics students working with electronics (Worcester Polytechnic Institute, 2019)

Chapter 3: Methodology

Our project goal is to create guidelines for high-quality, online STEAM education content for teachers to follow at home and in a common facility for educators in Panama by conducting research to propose studio technology and makerspace equipment. To fulfill the guidelines and prepare for the facility phase of this project, we need to acquire ideas and information from various individuals. This group will include students involved in virtual learning, professionals who create online content, and prospective instructors who will use this facility. This facility will begin construction after the current stay-at-home order of the COVID-19 pandemic is lifted by the Panamanian government. In order to achieve our project goal, our team developed three objectives to complete:

1. **Identify the Current Methods of Virtual Learning and the Obstacles.**

The current COVID-19 quarantine has forced many educators to adapt their content into a virtual format. Consequently, there is an ample number of teachers and students currently available who have, at a minimum, minor experience in online learning. This project will conduct surveys of these populations to identify the most beneficial practices and common concerns with virtual learning. Following these surveys, the team's plan is to conduct surveys with educators outside of Panama developing online learning content.

2. **Obtain the Perspective of Current Instructors.**

Once we have conducted surveys of students and teachers, the next step is to refine this data by interviewing Panamanian educators to obtain qualitative data about their individual successes and failures with online learning. The results from these interviews will increase our ability to effectively communicate with Fundesteam and their instructors to determine the necessary components for effective online learning and identify current best practices for

creating online content. The idea is to generate a set of guidelines for our project from these conversations and data analysis.

3. **Develop Recommendations for the Structure of the Facility.**

The secondary aspect of these guidelines is to advise Fundesteam about the future creation of an online learning and makerspace facility. To that end, we will interview makerspace educators to acquire qualitative data about the operation and implementation of makerspace education in STEAM learning. The discussions with educators and responses from the surveys will influence recommendations for the design of the facility.

3.1 Identify the Current Methods of Virtual Learning and the Obstacles

The first step in this investigation will be to conduct surveys of both the general populace and educators to acquire data about online learning (see Appendix A and B). These surveys will address the complexities of virtual learning from students and educators currently involved in online learning. Inquiries of the general populace will yield data about occupation, age, previous education, and personal preferences towards STEAM education (see Appendix A). This survey will also obtain information from students currently using online learning, identifying challenges, resolutions, and outcomes.

The survey for educators will identify where they traditionally provide content (i.e. public school, private institution, website, ect.), the level of instruction (i.e, elementary school, collegiate), and the subject matter. The questions will determine how these educators use resources for the creation of online content and resources for publication and proliferation. The team designed these surveys to identify the most beneficial practices and common concerns of these processes.

Following conducting these surveys, the team plans to interview 5-8 Panamanian educators involved in online learning education (See Appendix C). Through these interviews we plan to receive a more in-depth idea on how educators are adapting content into virtual format designated for online learning practices. Through personal connections from past and current educational systems, the team plans to reach out and work with educators working with online learning. We will conduct these interviews through platforms like live video conferencing and email.

The goal is to study techniques and challenges educators face when developing virtual learning content. Through the interviews the team hopes to identify specific techniques educators are implementing to overcome issues experienced when adapting content. The interview questions will also inquire about unique techniques educators may be implementing to improve online education content. Following the interviews, The team will use a qualitative coding process to analyze techniques and uncover common online learning processes. The team will influence the guidelines for Fundesteam and their educators with this information received in the interviews with educators.

3.2 Obtain the Perspective of Current Instructors

After gathering the data from the surveys, the team will further refine data by interviewing educators currently operating online education (See Appendix C). Fundesteam is well integrated into the Panamanian education system and will work to contact these educators. The team will conduct these interviews over two branches of communication. For educators who speak fluent English, the team will conduct these interviews live with video conferencing. For educators who primarily speak Spanish, the plan is to conduct these interviews by asking all the questions in Spanish via email and receiving responses that will require translation. The goal of

these interviews is to study how instructors in Panama struggle specifically with certain aspects of virtual learning and identify any steps taken to overcome obstacles. The interview questions also inquire about unique practices each educator might employ that they believe improves the online experience of students they teach. Subsequently, the team will utilize qualitative analysis coding techniques to uncover any commonalities among these practices. By identifying pedagogical techniques used to overcome specific struggles and commonalities of the best practices of online learning, the team will identify information received from the interviews conducted and implement these recommendations into our guidelines.

3.3 Develop Recommendations for Resources and the Structure of the Facility

The final element of this project is to apply the results from the methods proposed above to provide recommendations concerning the topics of an online learning and makerspace facility in Panama. The results from online learning surveys and interviews will likely focus on technical resources that can improve the creation of online educational content. In order to offer recommendations for the makerspace aspect of the facility, the team will conduct interviews of makerspace educators (see Appendix D) to learn about the interactions of makerspaces and STEAM education. Similar to the questions with online educators, these interviews will discuss challenges of makerspace learning and how educators overcome them. The team intends to conduct interviews via video conferencing for educators at the Foisie Innovation Studio, the Technocopia makerspace, and the Worcshop makerspace. The project team will contact more makerspace educators through the Hackerspace education registry to further interview individuals outside the cultural and economic context of Worcester, MA. The analyzed results from these interviews will further influence our recommendations to Fundesteam about the equipment and design of the online learning and makerspace facility that they envision.

3.4 Summary

Through the three objectives stated above in our methodology section, the team plans to gather a multitude of important information on resources and processes used in online learning and makerspace education. These aspects identified via surveys and interviews will aid in the creation of guidelines for an online learning and makerspace facility and for Fundesteam educators creating virtual learning content from home. With the addition of guidelines for at-home educators, Fundesteam will be able to accommodate a larger community of individuals inside and outside of Panama to create high-quality STEAM education content. These guidelines will present Fundesteam with a wide array of recommendations of resources to implement in the online learning and makerspace facility. The makerspace portion of the facility will allow Fundesteam to enhance the quality and outreach of their already implemented hands-on-learning after-school programs.

The addition of this facility in Panama will enable Fundesteam and many other educators the ability to deliver a higher quality of online education for Panamanian children. The facility will be able to increase the amount of Panamanian children exposed to STEAM learning content at an earlier age, potentially providing an increase in the economic status of Panama through this younger generation of innovators. Fundesteam's plan is to include educators outside of the country to create virtual STEAM content for Panama, giving local children access to a wider array of STEAM content. This extensive content supplied will allow Panamanian children to receive a more indepth STEAM education than before. Children in Panama will then have the opportunity to enhance their problem solving, critical thinking, and analysis of data skills like children involved in educational systems found in model STEAM countries. These skills will

introduce Panama's younger generation to a more cohesive education preparing them for a technologically advanced society and evolving workforce.

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Appendices

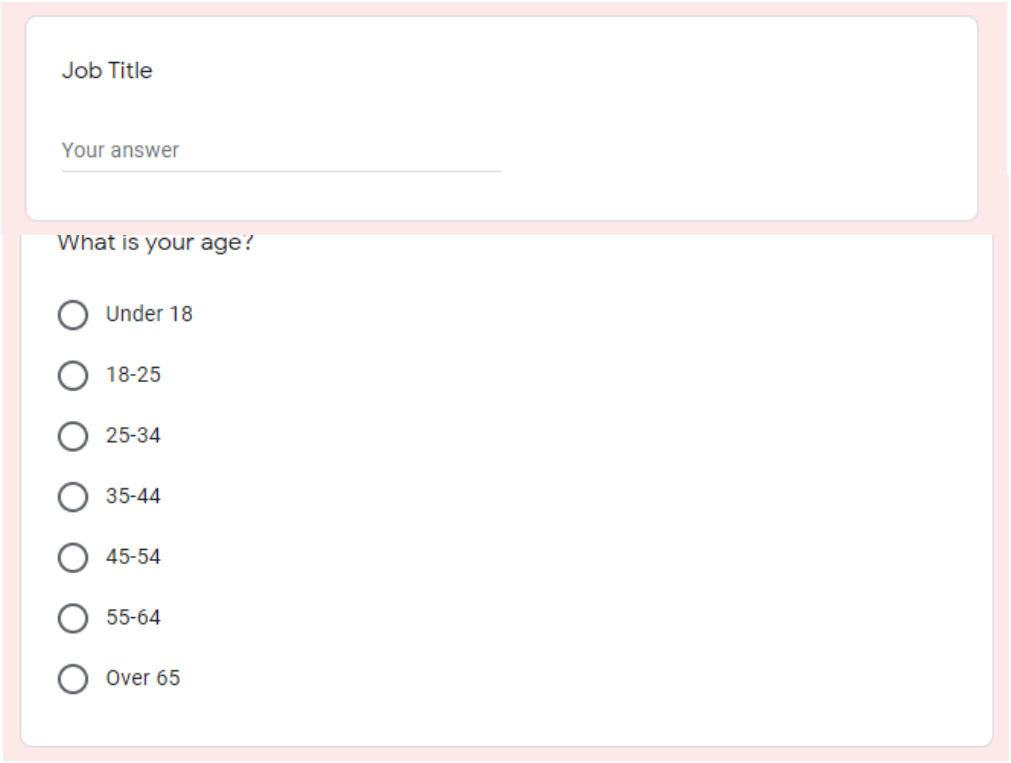
Appendix A: Survey for General Populace- K-12 STEAM Education

Opening Statement:

Hi, we are Nicole Racca and William Aaron, two Worcester Polytechnic Institute (a university in Massachusetts) undergraduate students working with the Fundesteam Corporation in Panama City, Panama for our Inter Qualifying Project! We are working to create a center in Panama for teachers to create online K-12 STEAM content for Panamanian children, including any possible resources teachers might need.

This online survey will be conducted completely anonymously, no information gathered will be linked to one's identity, and all identities will be kept confidential. All content used will be discussed in regards to a confidential sampling group. Feel free to skip any questions you want to.

Survey Questions:



What is the highest degree or level of school you have completed?

- ○ Less than a high school diploma
- ○ High School Degree or Equvalent
- ○ Undergradua
- ○ Bachelors Degree (e.g. BA, BS)
- ○ Masters Degree (e.g. MA, MS, MEd)
- ○ Doctorate (e.g. PhD, EdD)
- ○ Other: _____

What type of K-12 education did you have? (Choose all that apply)

- ☐ Public
- ☐ Private
- ☐ Charter
- ☐ Other: _____

What was your top 3 favorite subjects during K-12 education? (Choose 3)

- ☐ Science
- ☐ Math
- ☐ Social Studies
- ☐ English
- ☐ Art
- ☐ Physical Education
- ☐ Technology
- ☐ Foreign Language
- ☐ Music
- ☐ Other: _____

When you were younger what STEAM subject were/would you be interested in? (Check all that apply)

- [ ] Science
- [ ] Technology
- [ ] Engineering
- [ ] Art
- [ ] Math
- [ ] N/A

Would you have had an interest in a Science course in: (Check all that apply)

- [ ] Biology
- [ ] Chemistry
- [ ] Physics
- [ ] Geology
- [ ] Astronomy
- [ ] Anatomy & Phisology

Would you have had an interest in a Technology course in: (Check all that apply)

- [ ] Computer Programming
- [ ] Robotics
- [ ] Game Design
- [ ] Auto-CAD (Computer Aided Design)
- [ ] Computer Literacy
- [ ] Circuitry (building circuits and their elements)
- [ ] Other: _____

Would you have had an interest in an Engineering course in: (Check all that apply)

- [ ] 3-D Printing
- [ ] Machining (Laser Cutting, Router, Lathe, etc.)
- [ ] Materials
- [ ] Engineering Design Process
- [ ] Engineering Challenges

Would you have had an interest in an Art course in: (Check all apply)

- [ ] Audio/Music Editing
- [ ] Photoshop
- [ ] Video Editing
- [ ] Digital Design
- [ ] Digital Animation
- [ ] Photography

Would you have enjoyed a Math course in: (Check all that apply)

- [ ] Pre-Algebra/Algebra
- [ ] Geometry
- [ ] Trigonometry
- [ ] Arithmetic
- [ ] Data Analysis
- [ ] Calculus

Are you currently involved in Online Learning?

- ◯ Yes
- ◯ No

Are you experiencing any challenges in Online Learning?

- ◯ Yes
- ◯ No

If you answered yes, what challenges have you been facing?

Your answer

What changes would you like to see made to improve your experience?

Your answer

Do you consent to the use of your responses in our research?

- ◯ Yes
- ◯ No

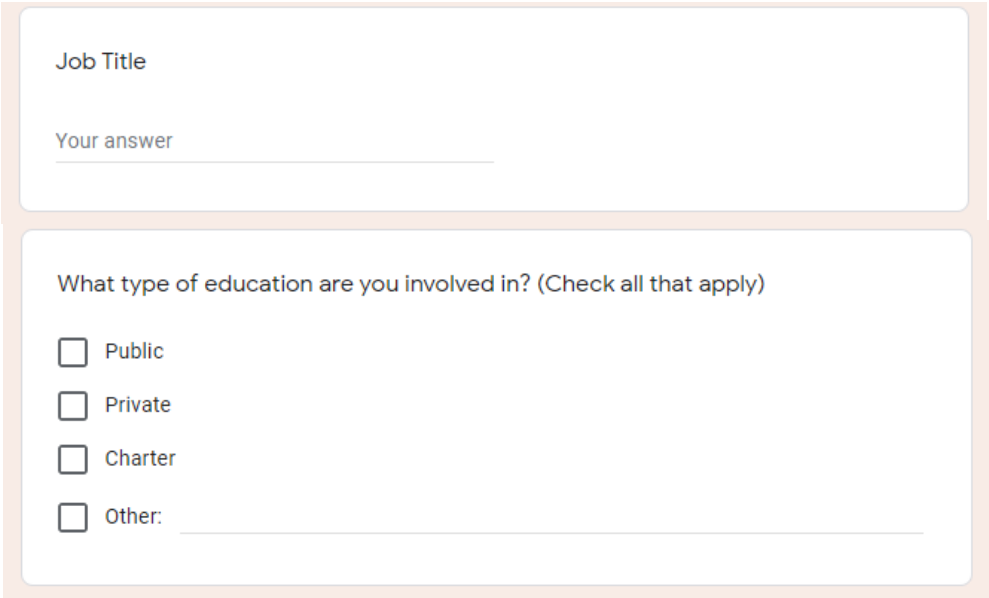
Appendix B: Survey for Current Teachers- Teachers and Online Learning

Opening Statement:

Hi, we are Nicole Racca and William Aaron, two Worcester Polytechnic Institute (a university in Massachusetts) undergraduate students working with the Fundesteam Corporation in Panama City, Panama for our Inter Qualifying Project! We are working to create a center in Panama for teachers to create online K-12 STEAM content for Panamanian children, including any possible resources teachers might need.

This online survey will be conducted completely anonymously, no information gathered will be linked to one's identity, and all identities will be kept confidential. All content used will be discussed in regards to a confidential sampling group.

Survey Questions:



What level of education are you involved in?

Your answer

What subjects do you teach?

Your answer

Are you currently developing online lessons *

- ◯ Yes
- ◯ No

What resources have you used to create these online lessons?

- ☐ Document Cameras
- ☐ White Boards
- ☐ Projectors
- ☐ PowerPoints
- ☐ Digital Writing Services (like OneNote)
- ☐ Videos found online (e.g. previously done demonstrations, other recorded lectures, etc.)
- ☐ Other: _____

What resources do you lack (e.g. higher quality microphones, document cameras, resources for demonstrations, etc.), if any?

Your answer

If you were to create online content and had the option to use any resources, what would you like? How would you apply it, and what lessons would it be used for? *

Your answer

If you had the opportunity to have these teaching amenities readily at a nearby facility, would you travel outside of your home to create better content for your students? *

- ○ Yes
- ○ No

What are you using to broadcast/upload your class content?

- ☐ Google Classroom
- ☐ Zoom
- ☐ Blackboard
- ☐ Echo 360
- ☐ Canvas
- ☐ Other:

Are you experiencing any trouble with creating and posting online content?

- ◯ Yes
- ◯ No

If yes, what are your top issues/concerns?

Your answer

What is/are the thing(s) you believe you need to improve on these issues/concerns?

Your answer

Appendix C: Interview Questions for Online Learning Educators (Non-Panamanian Based and Panamanian Based)

Informed Consent Considerations:

- Ask open ended questions without leading the question for the interviewee.
- Inform the interviewee of their choice of anonymity.
- If a question generates discomfort for the interviewee, do not pry and move on to the next question.

Introduction:

Hello ____. Hi, we are Nicole Racca and William Aaron, two Worcester Polytechnic Institute (a university in Massachusetts) undergraduate students working with the Fundesteam Corporation in Panama City, Panama for our Inter Qualifying Project! We are working to create a center in Panama for teachers to create online K-12 STEAM content for Panamanian children, including any possible resources teachers might need.

We would like to interview you about your experiences with online learning. If you don't mind, could we have your permission to record this interview to make sure we capture your responses? If you would prefer to not be recorded, that is perfectly fine and we will take notes instead. Any information you share with us is completely confidential and will only be used for research purposes with your permission. Do you consent to being quoted in our report? We will not identify you by name in any of our writing to preserve the confidentiality of your information. If you prefer to not be quoted, you have the option to remain anonymous. If we ask a question that you do not want to answer, let us know and we will move on to the next one. If you don't understand our question, let us know and we can try and rephrase the question.

Our project will focus on improving virtual learning practices, offering solutions to common concerns and problems, and recommendations for the creation of quality online learning content. This report will be readily available online once we finish writing it, and we can email you the report as well if you wish. Do you have any questions before we begin?

Date/Time: _____

Location: _____

Interviewers: _____

Interviewee: _____

Interviewee Role: _____

Consent Questions:	**Yes**	**No**
Do we have permission to digitally record this interview?		
Would you prefer to remain confidential, or can we use your name in our report?		
Would you like us to share our paper with you once it is completed?		

Interview Questions:	**Response:**
What is your level of experience with education in general? (i.e how long have you been teaching? Do you have any certification or degree in teaching?)	

Are you currently running online classes for education, or have run online classes within the last three months?	
For how long have you been using online education? How long was your most recent time period of online teaching?	
What age groups did you teach when running online classes, which demographic?	
What subject or subjects did you teach during this time period?	
What are some examples of the types of content you have created for this performing online education in this subject? (i.e. live lectures, video's, articles, interactive applications?)	
Describe your typical "lesson" in this context.	
What aspects of your online learning content, if any, involved asynchronous learning?	
What aspects of your online learning content, if any, involved synchronous learning?	

What is your process to prepare for the creation of your online learning content? How much time does this process take on average?	
What, if anything, works well with the creation of your online content?	
What are the resources you commonly employ in order to create this online learning content successfully?	
What, if anything, are some of the challenges you face when creating online learning content?	
Can you think of any resources which, if you had access to, would help alleviate some of the challenges with creating online content?	
How do you communicate with your students? Either/both synchronously or asynchronously?	
What, if anything, works well with your communication with students?	
What, if anything, are some of the challenges you face when communicating with students?	

What is your method to ascertain how much a student has learned?	
As an educator, do you believe that online education is successful at teaching your students specifically? Do you believe it is successful in general?	

Conclusion:

Thank you so much for taking the time to talk with us today and participating in our research. Is there any in the interview which you would like to talk more about? Is there anything else which we haven't talked about yet that you would like to cover? Would you like to review our notes and/or a transcript of this interview? If you have anything more you would like to add, you can reach us at the email address gr-fsteam20@wpi.edu . Thank you for your time.

Appendix D: Interview Questions for Makerspace Educators

Informed Consent Considerations:

- Ask open ended questions without leading the question for the interviewee.
- Inform the interviewee of their choice of anonymity.
- If a question generates discomfort for the interviewee, do not pry and move on to the next question.

Introduction:

Hello ____. Hi, we are Nicole Racca and William Aaron, two Worcester Polytechnic Institute (a university in Massachusetts) undergraduate students working with the Fundesteam Corporation in Panama City, Panama for our Inter Qualifying Project! We are working to create a center in Panama for teachers to create online K-12 STEAM content for Panamanian children, including any possible resources teachers might need.

We would like to interview you about your experiences with makerspace education. If you don't mind, could we have your permission to record this interview to make sure we capture your responses? If you would prefer to not be recorded, that is perfectly fine and we will take notes instead. Any information you share with us is completely confidential and will only be used for research purposes with your permission. Do you consent to being quoted in our report? We will not identify you by name in any of our writing to preserve the confidentiality of your information. If you prefer to not be quoted, you have the option to remain anonymous. If we ask a question that you do not want to answer, let us know and we will move on to the next one. If you don't understand our question, let us know and we can try and rephrase the question.

Our report will focus on recommendations for the creation of an online learning facility and makerspace devoted to STEM education. The report will offer solutions to common

concerns and problems, and recommendations for the resources and design of this facility. This report will be readily available online once we finish writing it, and we can email you the report as well if you wish. Do you have any questions before we begin?

Date/Time: _____

Location: _____

Interviewers: _____

Interviewee: _____

Interviewee Role: _____

Consent Questions:	**Yes**	**No**
Do we have permission to digitally record this interview?		
Would you prefer to remain confidential, or can we use your name in our report?		
Would you like us to share our paper with you once it is completed?		

Interview Questions:	**Responses:**
What is your level of experience with education in general? (i.e how long have you been teaching? Do you have any certification or degree in teaching?)	
How long have you been running makerspace-based education classes?	
In any classes you have taught within the past 12 months, what age groups did you teach when running these makerspace-based classes. Which demographics?	

What, if any, subject(s) did you teach during this time period?	
What, if any, kind of technical skills did you teach during this time period?	
Describe your typical “lesson” in this context	
What is your process to prepare for your classes? How much time does this process take on average?	
What, if anything, works well with about your methods of teaching?	
What are the resources you commonly employ in order to prepare your lessons? To what extent do they involve physical apparatus?	
What, if anything, are some of the challenges you face when creating or running your lessons?	
Can you think of any resources which, if you had access to, would help alleviate some of the challenges with creating your lessons?	
What is your method to ascertain how much a student has learned?	

As an educator, do you believe makerspace education is successful at teaching your students specifically? Do you believe it is successful in general?	

Conclusion:

Thank you so much for taking the time to talk with us today and participating in our research. Is there any in the interview which you would like to talk more about? Is there anything else which we haven't talked about yet that you would like to cover? Would you like to review our notes and/or a transcript of this interview? If you have anything more you would like to add, you can reach us at the email address gr-fsteam20@wpi.edu . Thank you for your time.