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INTEGRATING STEM EDUCATION WITH ENTREPRENEURSHIP PRACTICES AT MIDDLE SCHOOLS: FEASIBILITY STUDY AND PRELIMINARY RESULTS

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Integrating STEM Education with Entrepreneurship Practices at Middle Schools: Feasibility Study and Preliminary Results

Synopsis:

STEM-Inc is a NSF-Funded afterschool program designed to introduce and engage middle school students in STEM related fields. Involving students in exciting real-world projects, STEM-Inc not only helps students develop practical skills in engineering and computer science, but also incorporates business and entrepreneurship practices to reinforce the learning outcomes.

Integrating STEM Education with Entrepreneurship Practices at Middle Schools

ABSTRACT:

STEM-Inc. is a 3-year NSF ITEST project designed as an after-school program targeting 7th and 8th grade students from traditionally underrepresented groups in Anaheim, California. This project encourages the creation of a mini technology business ‘incubator’ in an afterschool program for junior high students. It is a collaboration involving California State University, Fullerton (CSUF)’s Colleges of Engineering and Computer Science (ECS), Business and Economics, and Education; and the Anaheim Union High School District (AUHSD). Its goal is to make junior-high students and their parents aware of STEM career paths in addition to engage and attract the students to STEM fields and careers. To this end, the project focuses on getting the students involved in exciting real-world projects that involve ECS and business concepts. Students participating in STEM-Inc work in groups to complete their project and each group is led by peer leaders. The students are also supervised and mentored by AUHSD teachers and CSUF College Mentors. As a design and development project, research questions frame formative data collection and analysis to address aspects of the design that are succeeding and others that require revision. Summative measures focus on what teachers and students learn, as well as attitudes toward science and engineering and self-efficacy.

1. INTRODUCTION

The beauty of entrepreneurship is that it can be learned at an early age. Exposing students early (and often) to the world of entrepreneurship can make a lifelong impact. Whether the student pursues his or her own startup, or a STEM related career, the skills of an entrepreneur are invaluable. Therefore, one of the objectives of STEM-Inc. is to examine the potential of developing and retaining student interests in STEM, by introducing entrepreneurship practices. This program helps students break down the natural mental barriers, such as the common negative thoughts of “I am not good enough” or “it is too difficult”, that often times limit students from pursuing STEM fields. The integration of STEM and entrepreneurship practices in STEM-Inc. is primarily introduced through the process of design thinking, business planning,

and business communication. Specific objectives are defined under each goal of the project as follows,

GOAL 1: To engage diverse junior high students in engineering and computer science by familiarizing them with relevant career and business/entrepreneurial opportunities.

GOAL 2: To help diverse students develop career-readiness skills in engineering and computer science.

GOAL 3: To expand teachers' understanding of engineering and computer science career opportunities and the skills students will require to pursue them.

2. Program Description

STEM-Inc. is an afterschool program that exposes Junior High school students to engineering concepts and entrepreneurship practices. Throughout the school year, students learn about 3d design, 3d printing, circuitry design, Arduino, MIT app inventor and how to program a robotic car to perform certain tasks. Simultaneously, students engage in activities that expose them to the world of an entrepreneur. Activities that the students engage in include: developing a business plan, formulating a marketing strategy, understanding their company's finances and perfecting their ability to communicate fast and effectively (fast pitch). Data collected from pre and post surveys revealed that students in the program appreciate and understand the importance of having the skillset of an engineer and the savvy business mind of an entrepreneur (Figure 1). Half way through the school year, students utilize the knowledge they acquired from both business and engineering and work on projects that solve problems within their community or a less-developed country. Furthermore, the program aims to introduce students to an environment that mirrors the real world workforce.

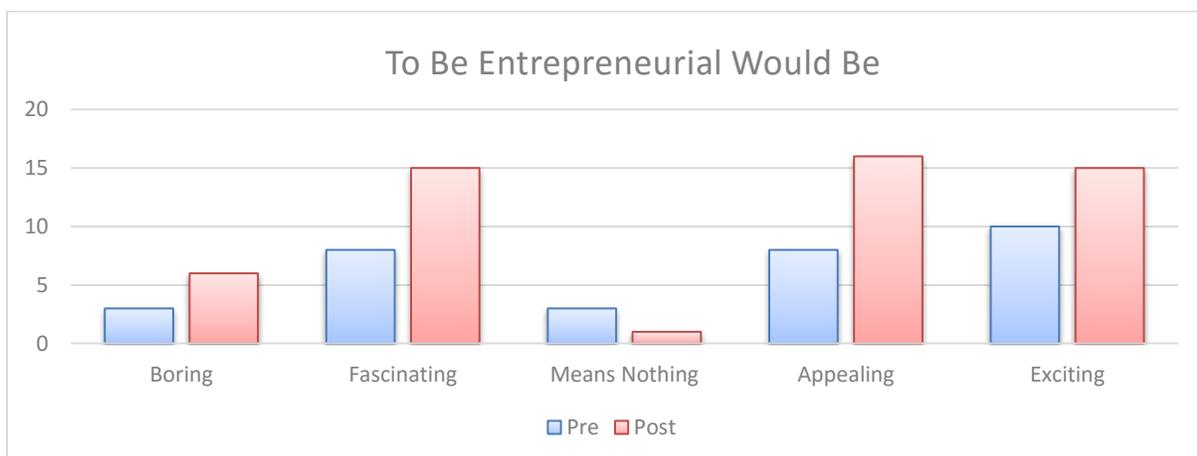


Figure 1. Pre and Post Student Response- Arroyo Research Services

2. Methodology

Participants

The STEM-Inc. program targets 7th and 8th graders from various Junior High schools within AUHSD especially those from traditionally underrepresented groups. Figure 2 illustrates the effort made to recruit students from traditionally underrepresented groups. An overarching goal is to make junior-high students and their parents aware of STEM career paths and engage/ attract the students to STEM fields and careers. Consequently, the project focuses on getting the students involved in exciting real-world projects that involve not only engineering and science concepts but also business and entrepreneurship practices. Participating students work in groups to complete their project and each group is guided by a student peer leader from within the group.

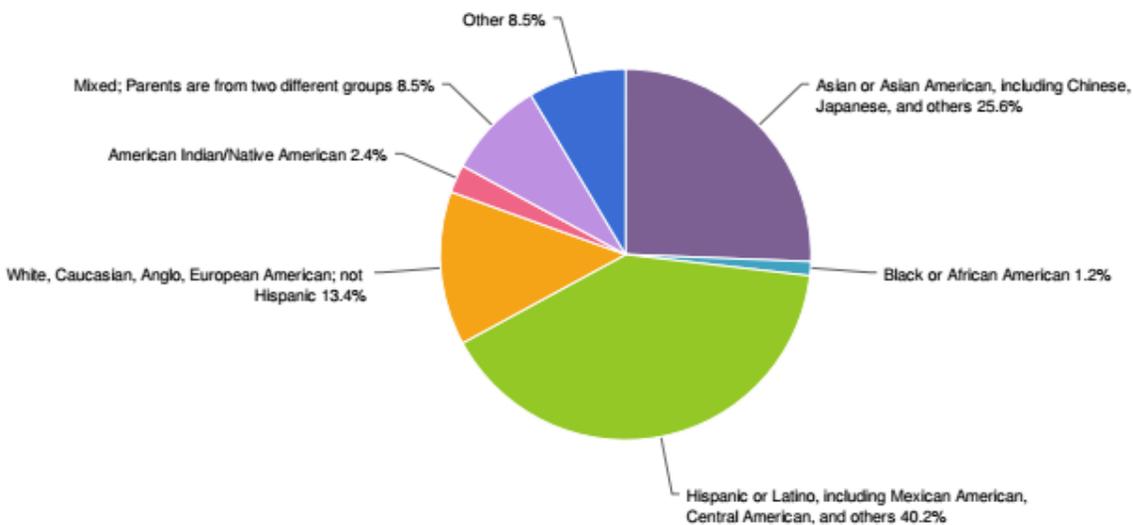


Figure 2. Ethnicity of Students in STEM-Inc. Program-Arroyo Research Services

In order to test the veracity of this pedagogic framework, the researchers monitored progress through the use of a longitudinal study. To measure results, the researchers used a comprehensive survey to measure the students' attitude towards STEM in general and more specifically their attitudes in regards to how STEM related to their futures, including potential career choices, using Likert-scale questions. These surveys were administered at the beginning of the research and at the end of each school year. Currently, two surveys have been completed

(initial and conclusion of first year) and a third survey is being administered. Additionally, personal observations from the Primary Investigators and mentors were documented along with interviews of students who participated in the STEM-Inc. afterschool program.

This design and development research study integrates mixed methods using both quantitative and qualitative approaches to address the following research questions:

1. Does adding business entrepreneurship concepts to both the content and design of collaborative student experiences result in improved student understanding of entrepreneurship, and improved student STEM outcomes (e.g., engagement, interest, attitudes, leadership/workforce skills)?
2. Which program components and activities best facilitate students' active engagement and interest?
3. Is teacher mastery of the entrepreneurship concepts related to student success in the project?
4. What pedagogical challenges, including those related to the combination of entrepreneurship, engineering and computer science, do teachers experience during the program? How and to what extent are these overcome?

At the end of the year, student outcomes related to concept acquisition in STEM and entrepreneurship, as well as the overall project STEM goals will be compared using ANOVA (analysis of variance), MANOVA (multivariate analysis of variance), or if groups were significantly not equivalent at baseline, multiple regression. Although the nested nature of the data points toward HLM (hierarchical linear models), we expect too few cases at level 2 to warrant its use or for it to provide extended value over and above well-constructed regression analyses.

3. Findings

Participants

Participating Junior High students were surveyed in the fall and the spring in regard to their knowledge of and interest in STEM studies and careers, understanding of connections between business/entrepreneurship and STEM careers, confidence/self-efficacy in STEM, and their

workforce skills. All students reported participating in STEM Inc. because they were interested in robotics, mobile app development, engineering, or the program just sounded fun. When asked what they learned from the program, during the spring survey administration, most reported skills related to engineering and mobile app development, as well as gaining business skills and knowledge (e.g., “I learned how to give a 60 second pitch”). In addition, pre and post data collected shown in figure 3, shows that student interest in starting/owning their own business, slightly increased from those who were extremely interested.

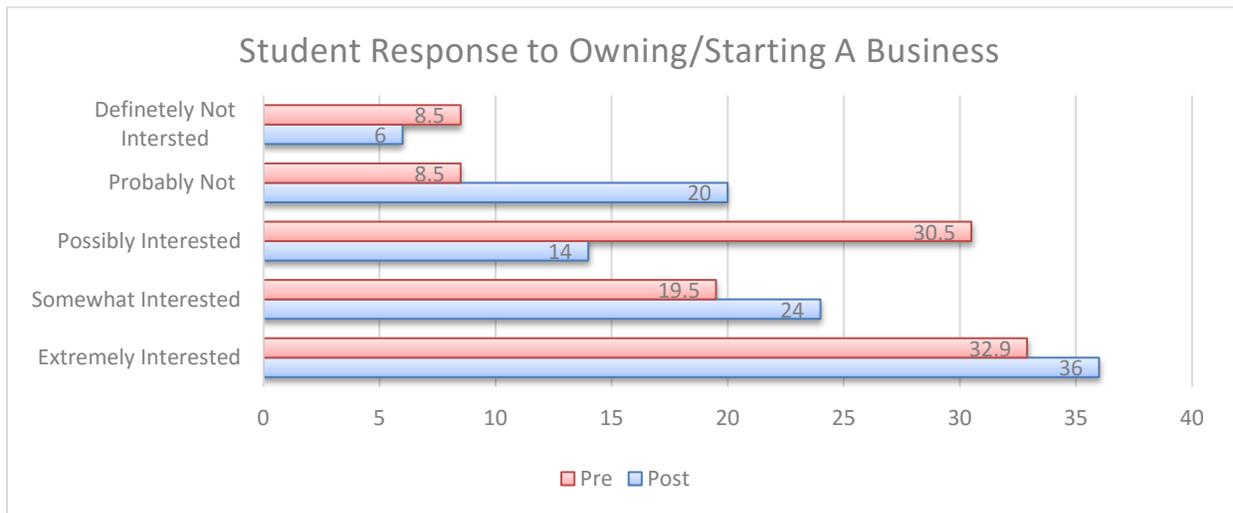


Figure 3. Pre and Post Survey Student Response-Arroyo Research Services

4. Conclusion

As a design and development project, research questions framed formative data collection and analysis to address aspects of the design that are succeeding and others that require revision. Summative measures focused on what teachers and students learn, as well as attitudes toward science and engineering and self-efficacy. From preliminary results obtained from the first year of STEM-Inc implementation, a positive attitude towards STEM study was observed and documented. Among most student participants who, at the same time, demonstrated a good understanding of connections between STEM subjects, and related business and entrepreneurship practices.

5. Acknowledgements

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