An ROI Comparison of Initiatives Designed to Attract Diverse Students to Technology Careers

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ABSTRACT

This study examines two alternative interventions designed to attract diverse students to pursue information technology or, more generally, STEM (science, technology, engineering, and math) careers from a Return on Investment (ROI) perspective. More specifically, this study examines the effectiveness and efficiency of single-day and multi-day program formats by comparing students' propensity to pursue computer information systems and technology related careers. Using an ROI perspective of comparing relative costs to students' perceived outcomes, our findings suggest that the single-day model is equally effective as the multi-day model at moving students' propensity to pursue information technology careers, albeit at a lower cost. This suggests that the single day model is a better choice from an ROI perspective and offers the best investment opportunity for choosing which program format to use for future interventions. These findings, while specific to a single comparison of two alternative information technology interventions, are useful as they contribute valuable knowledge and may be applicable to the design and evaluation of other STEM-influencing programs.

Keywords: STEM, Diversity, Interventions, Return on investment (ROI)

1. INTRODUCTION

K-12 educators, higher education, government institutions, and business and industry partners have accomplished much in the pursuit to attract diverse populations to study STEM-related disciplines (Brookshire et al., 2008; McCullough 2002). However, a critical shortage of scientists and engineers in the U.S. remains. The Executive Office of the President and the National Science Foundation suggest tapping into underrepresented populations, specifically minorities and women, to fill the void (National Science Foundation, National Center for Science and Engineering Statistics, 2013; Olson and Riordan, 2012) given the disparity that exists between the ratios of diverse populations in our society and the number of diverse persons with high-level information technology related careers. The National Science Foundation reports that in 2012, underrepresented men and women earned 18.8% of undergraduate degrees awarded in science and engineering (National Science Foundation, National Center for Science and Engineering Statistics, 2015). Diverse populations are less likely to have access and exposure to information technology resources during their K-12 education (Chisholm, Carey, and Hernandez, 2002) and are, therefore, less likely to be interested in acquiring information technology education and in pursuing information technology careers.

Previous efforts to increase diverse students' interest in information technologies and STEM have included or were followed by studies to determine the effectiveness of particular strategies and approaches (Craig, 2014; Miliszewska and Moore, 2010; Mouza, 2008). Assessing the effectiveness of a program's ability to increase a student's desire to study computing technologies and enroll in and complete undergraduate computing technology degree programs is essential given that pilot funding for these programs is temporary. Stewards of programs to produce more computing technology graduates are obliged to measure, report on, and update their programs to ensure the programs produce cost-effective outcomes.

The Federal Reserve Bank of San Francisco reports that there is an increased interest in "impact investing." Specifically, when making socially responsible investments, companies and government agencies seek a Pay for Success (PFS) agreement to continue funding (Ragin and Palandjian, 2013). PFS backers pay service providers based upon measurable predefined prevention or intervention outcomes. Key aspects of PFS agreements include predefined investments (similar to grants) and the requirement that desired outcomes must be measurable.

Evidence based methods such as ROI are increasingly being used to document achievements in sponsored prevention and intervention programs (Kuklinski, 2015). We propose adopting ROI methodologies to examine the cost-effectiveness of interventions designed to increase interest in STEM careers. For purposes of this paper, we define the Investment component of ROI to include not only the "in dollars" quantifiable costs, but also the unquantifiable investments, such as volunteer efforts and in-kind donations. By focusing on ROI, we hope to simultaneously promote and improve the use of investment resources to increase the number of students receiving effective (positive ROI) intervention experiences. We hope to provide decision makers with justification for investing new financial resources needed to best support intervention efforts.

This paper continues with a review and summary of existing programs focused on encouraging diverse students to pursue STEM careers and discuss how these programs report on outcomes and costs. Next, we present our comparison model where two similar programs were conducted and where both costs and outcomes were tracked for the purpose of comparing ROI. We end with a discussion of our findings and offer suggestions to those offering intervention programs on ways to better track the costs and outcomes of their programs so that they can report results using the ROI framework to be able to better distinguish and recognize the most effective programs.

2. LITERATURE REVIEW

There are a multitude of programs designed to encourage middle and high school young women, first-generation college students, and commonly recognized minority populations to pursue post-secondary education in information systems, information technologies, and STEM. While investigating programs conducted in Australia, Craig (2014) noted that many interventions, including summer camps, computer clubs, awareness-raising events, and workshops made a difference in increasing participation and interest. Craig's (2014) findings also indicate that many programs have good intentions, but most are not evaluated due to a lack of time, expertise, and money.

For each program listed below, we report the program's goals, intervention, target population, duration, format, and cost as available. These data, along with each program's reported outcomes, are summarized in Table 1.

2.1 Increasing Student Interest in STEM

Tangney and colleagues (2010) describe a generic model for an outreach workshop targeting high school students. The model uses group work, is project based with an emphasis on visual programming languages, takes place during school, and occurs in a "computing clubhouse" environment. The 39 participants were almost equally divided between males and females and were 15 or 16 years of age. The overall response to the workshop experience was very positive. Participants indicated that they would continue learning to program computers and reported that they gained a better understanding of computer science college coursework.

Grant and colleagues (2013) created a 4-week summer program designed to increase student interest in science and technology by blending hands-on biology, chemistry, and technology modules addressing the global issue of obesity. 29 participants were almost equally divided between 11^{th} and 12^{th} grade males and females, mostly self-identified as African American/Black. Upon completion, 68% of the students indicated plans to pursue a STEM major.

Hayden and colleagues (2011) studied the outcomes of a weeklong summer camp that targeted predominately-Hispanic 7^{th} and 8^{th} grade students. The 72 students were exposed to a variety of collaborative science activities and interactions with experts and peers. Using a pre- and post-test of student attitudes and interests, findings were divided. Both males and females showed an attitude change over time, but the only significant improvement in attitude was in males.

Christie and Healy (2006) created a workshop to reduce the typical "geek" stereotype of the IT profession to attract women to the IT field. Over five years, the workshop has served 152 10-year-old young women. Emphasis is placed on female role models. The curriculum includes hardware, robotics, 3D graphics, computer forensics, animate objects, and multimedia. No data was gathered but an "attendees' reaction" section reports many positive comments from the participants.

The ACES program (Adventures in Computers, Engineering, and Space) is described by Wigal and colleagues (2002) and addresses the gender gap in engineering and computer science. The one-week residential summer camp for 7th and 8th grade girls concluded with a one-day session during the school year. At the time of publication, 24 girls from diverse backgrounds participated. Pre- and post-test questionnaires did not provide consistent information to draw conclusions about the program's effectiveness.

To evaluate the long-term effects of a 2-week residential engineering outreach program for rising 7th grade girls, Demetry and colleagues (2009) gather data from 176 girls over five years. They were unable to report statistical significance, although many of the outcomes (knowledge of engineering, choice of college major, etc.) trended in the expected direction. Demetry and colleagues did report that costs for the two-week residential program were up to $40,000 annually.

X-TEEMS (eXtra Technology, Engineering, Education, Mathematics and Science) was designed to promote interest in the STEM field. It included a two-week summer program for 62 rural and economically disadvantaged youth. After one week of engineering and one week of other STEM learning activities, the authors (Elam, Donham, and Solomon, 2012) found a significant improvement in attitude toward engineering.

Yilmaz and colleagues (2010) reported on the YESTexas one-week summer engineering camp that served thirty Hispanic high school girls. After one week of hands-on engineering projects designed to increase awareness of the field, they found no significant outcomes, but did report a large percentage of "expressed interest" in studying engineering.

In an attempt to convince girls of the importance of continuing math and science courses throughout high school, the "First Tech Camp for Girls" (Lanzer, 2009) was created. Hardware, digital media, web design, programming, cryptography, engineering, and networking topics were included in the weeklong program. No demographics or outcomes are reported.

The BUGS (Bringing Up Girls in Science) program addressed the goal of increasing 4th and 5th grade girls' academic achievement in science (Tyler-Wood et al., 2012). The two-week summer camp emphasized environmental science and included mentor/role models. BUGS participants were studied over the long-term and compared to contrast groups. Out of approximately 100 girls, the program produced ten college science majors, ten non-science college majors, and nine women moved into STEM professions allowing the authors to claim that BUGS participants have a higher perception of science careers than non-BUGS participants.

Miller and Phillips (2014) sought to determine whether 4th through 8th graders from rural, low-income communities had an increased attitude towards STEM upon completing a science, technology, engineering, arts, and math camp (STEAM). For four hours each day participants worked with NASA's Multi-Scale Magnetosphere education team to study the purpose, mission, and exploration of renewable solar and wind energy programs. Using pre- and post-tests, research findings indicated an increase in favorable perceptions toward engineering and a stronger disposition toward science in female middle school students.

Phillips and Miller (2014) sought to determine what influences a STEM career choice for boys and girls in elementary and middle school. A second STEAM camp emphasized the reconstruction of a replica of a NASA spacecraft and other space activities. Pre- and post-test findings stated that older students (6th-8th grade) showed a higher interest in STEM careers than younger students (4th-5th grade) and that females showed a higher interest in STEM careers than males.

The NSF Foundation's Middle Schoolers Out to Save the World (MSOSW) program Innovative Technology Experiences for Students and Teachers (ITEST) was funded from 2008 until 2011. MSOSW hoped to promote an interest in STEM careers in young students. Approximately 600 6th, 7th and 8th graders from five states participated in the three-year program. Christensen and colleagues (2011) reported significant positive changes in female participants' perception of math and technology. However, these were not accompanied by large changes in students' interest in STEM careers.

Lamar University's INSPIRED (Increasing Student Participation in Research Development Program) program was created to engage females and minorities and increase knowledge, interest, and participation in computing activities (Doerschuk, Liu, and Mann, 2011). Over two years of the program there were a total of twenty-five participants. Using pre- and post-quizzes and questionnaires, quantitative assessments showed an increased interest in computer science and in self-reported knowledge in computer science, robotics, and webpage development.

Berkeley Foundation for Opportunities in Information Technology (BFOIT) established in 1999 (Crutchfield et al., 2011), aims to expose pre-college young women and underrepresented racial and ethnic minorities to the fields of computer science and engineering. In the small quantitative assessment, the authors state that participants have a correlation to improved spatial reasoning after completing the program. Limited data is provided in the article.

Mohr-Schroeder and colleagues (2014) placed an emphasis on LEGO robotics and programming when attempting to determine that participating in a summer program would influence middle school students' interest in STEM. Following the 5-day program, they reported significant positive changes in "interest in a STEM career field." Approximately 30% of participants were recognized as underrepresented populations.

Georgia Computes (GaComputes), a six-year project funded by the National Science Foundation, was designed to improve computing education across the state of Georgia. GaComputes delivered programs that included summer camps, after-school/weekend workshops, and professional development for teachers to broaden participation in computing and engaging underrepresented groups (women, African Americans, and Hispanics). During six years, the program reported that over 5,000 K-12 students participated in some aspect of GaComputes; almost 3,000 students in summer camps and just over 2,000 in 3-4 hour workshops (Guzdial et al., 2014). At the end of six years, GaComputes reported that summer camp participants gained significant content knowledge in computing. These same participants showed statistically significant growth in their positive attitude towards computing (Guzdial et al., 2014). No results were reported for the 3-4-day workshop participants.

In what may be the most relevant study regarding youth intervention programs designed to increase STEM interest, Nugent and colleagues (2010) discovered that both week-long and three-to-four hour programs increased student attitudes toward STEM. They examined the impact of two interventions (week-long program and 3-4-hour program) with robotics and geospatial technologies on learning and attitudes towards (STEM). Only the week-long program enhanced STEM learning, as measured by a content test covering topics in computer programming, mathematics, geospatial technologies and engineering. However, both interventions increased student attitudes toward STEM. Surprisingly, only students enrolled in the short-term 3-4-hour program had significantly higher perceptions of the value of STEM, based on pre- and post-tests. In summary, Nugent and colleagues (2010) findings strongly support the notion that increasing interest and attitudes in STEM can be accomplished with short-term interventions. There was no emphasis on diversity in this study.

Three additional summer programs identified in the literature did not specify a goal of increasing diversity (Chen, Chang, and Tseng, 2015; Innes et al., 2012; van Delden and Yang, 2014). Describing a pilot study outcome for a robotics summer camp, Chen and colleagues (2015) noted positive experiences from the participants, but did not report any significant findings. Reporting on a week-long summer camp in robotics and computer programming with Java, van Delden and Yang (2014) found significant improvements in computer programming content knowledge, but no significant increases in the opinion questionnaire on "studying" computer science, engineering or attending the sponsoring institution. Innes and colleagues (2012) did report significantly higher STEM interest and self-efficacy after exposing 4^{th} through 9^{th} graders to one-day STEM workshops.

Table 1 summarizes each program's goal, intervention, duration/cost and reported outcomes to provide a comparison of each program. Few programs provided data regarding the amount of time spent on creating/planning activities, recruiting attendees, or overseeing the intervention. Readers should note that while there is some variation within individual programs, there are many recognizable consistencies among Goals and Interventions.

The program goals are relatively homogeneous (promote students' interest, awareness, and propensity to pursue STEM careers, opportunities, and degrees). Effort for the intervention is a combination of assembling the curricular content or knowledge emphasis, which includes the STEM learning activities, and identifying and recruiting the target population. The duration and cost can be determined by the contact hours and length of the program and the give tangible investment in dollars. The outcomes range from 'no effect' to significant increases in students' interest in STEM related careers and degrees.

2.2 Examining Cost Components

Only one study clearly stated the annual cost of the summer program (Demetry et al., 2009). Yet, even that report was unclear about which types of costs were included and excluded from the reported cost of the program. The lack of consistently reported cost data is noticeable and troubling. Many programs likely use volunteers and may not pay for space and material resources used, thus hiding the true investment. This makes it difficult to reliably report on a program's actual cost and, in turn, to use that cost in concert with the program's reported outcomes to measure a specific program's ROI.

If programs were able to consistently report on tangible costs (meals, stipends, lodging fees, etc.) and were to adopt a format to capture intangible costs (hours, square footage of space utilized, etc.), the basis for consistent comparisons would begin to be in place. In lieu of this, cost estimates could give a basis to enable simple comparisons.

2.3 Conclusions for Review of Literature

Our analysis of intervention programs corroborates prior findings (Craig, 2014; Heemskerk et al., 2004; Miliszewska, 2010). There is a strong indication that most programs designed to increase interest in STEM are created for a necessary purpose. That said, there is a lack of consistent design, assessment, cost reporting, and outcome evaluation. Programs that are evaluated do not consistently employ proven valid and reliable evaluation tools and do not report the true investment made. This makes it difficult to report the ROI for the intervention programs that affect students' interest in STEM, enhance students' awareness of STEM careers, and/or promote students' interest in future post-secondary STEM studies.

Author(s)	Program Goal	Effort for the Intervention	Duration/Cost	Reported Outcome(s)
Chen, Chang, and Tseng (2015)	Suggest knowledge integration, student understanding, and communication platform for a summer program	Design and construction of a robot for high school students	Four days, about eight hours a day 32 contact hours	Positive hands-on experiences but some difficulty in independent learning. No significant findings. N = 30
Christensen, Knezek, and Tyler-Wood (2011)	Promote interest in pursuing STEM careers	Program curriculum on power usage and power consumption for middle school age students	3-year in school program Approximate contact hours not presented	Females showed significant perception increases for math and technology; no changes in STEM career interest N = 500
Christie and Healy (2006)	Reduce the typical "geek" stereotype of the IT profession to attract women to the IT field	Hardware, robotics, 3D graphics, computer forensics, animated objects, and multimedia for 10-year-old females. Female role models were a component	3-day or 2-day workshop Approximate contact hours ranged from 14 to 20 hours	No data gathered. N = 152
Crutchfield et al. (2011)	Motivate participants to go to college, major in computer science, attend UC Berkeley, and major in CS at Berkeley	Lego Mindstorm, web programming with HTML, Alice, and Scratch for underrepresented minorities and female middle school and high school students	2-week summer program and year-round involvement Approximate contact hours not presented	Many positive testimonials and a correlation to improved spatial reasoning N = 50
Demetry et al. (2009)	Generate and sustain adolescent girls' interest in engineering and technology, motivation toward education and self confidence	Hands on engineering activities for rising seventh grade girls	Two-week residential summer camp Approximate contact hours not presented Cost of $40,000	Although trending positively, no significant findings for generating interest, motivating further engineering education or increasing self confidence N = 176
Doerschuk, Liu, and Mann (2011)	Increase participation of women and underrepresented minorities in computing (INSPIRED)	Programming with Java, robotics and web programming for early teenage females and underrepresented minorities	5 half day meetings over one week Approximately 20 contact hours	Significant increases in self-reported knowledge of CS, robotics and web programming, and self-reported increase in CS interest N = 25
Elam, Donham, and Solomon (2012)	Promote interest in learning STEM fields with an emphasis on engineering	One week of engineering and one week of other STEM fields were offered to rural and financially disadvantaged middle and high school students	Two-week summer program	Reported significant findings in improvement of attitude toward engineering N = 62
Grant, Malloy, and Hollowell (2013)	Increase student interest in science and technology	Blend of hands-on biology, chemistry & technology addressing the global issue of obesity. Student groups created websites as output for rising 11th and 12th grade students	4-week summer program Approximately 140 contact hours	68% of the students indicated that they plan to pursue a major in science, technology, engineering or mathematics No significant findings N = 29

Guzdial et al. (2014)	Georgia Computes is designed to broaden participation in computing and specifically to engage more members of underrepresented groups	Computer programming with Scratch and Alice for 4th through 12th grade students with about 50% underrepresented and 88% female	3-4 hour workshops or 5-day non-residential summer camp Approximately 4 hours for workshop attendees and 35 for summer camps	Students who participated in GaComputes summer camps experienced statistically significant gains in self-reported attitude towards computing N = 2000 No results were reported for 3-4 day workshops N = 2000
Hayden et al. (2011)	Promote student interest and attitudes toward careers in science, technology, engineering, and mathematics	Science activities including earth science, physical science, and life science for 7th & 8th grade students in high percentage Hispanic student classrooms	One-week summer camp Approximately 60 contact hours	Both males and females showed changes over time; only the improvement in attitude in males was significant. N = 72
Innes et al. (2012)	Raise awareness of electrical engineering as a field of study and career choice	Hands-on science, technology engineering and mathematics workshops for 4-9 grade students	1-day workshops Approximately 7 hours	Significantly improved students' perceptions of engineering and that engineers have a positive impact on the world N = 307
Lanzer (2009)	Identify the importance of math/science coursework	Program contained digital media, web design, programming, and cryptography, for young females	1 week Approximately 35 contact hours	None provided
Miller and Phillips (2014)	Improve the participants' attitudes towards STEM topics and STEM careers	Used NASA's Multi-Scale Magnetosphere education team to renewable energy. Emphasized STEAM (Science, Technology, Engineering, Arts and Math) for 4th through 8th grade students	10 days with four hour sessions each day Approximately 40 contact hours	Only the 8-grade students showed a significantly higher perception of STEM N = 48
Mohr-Schroeder et al. (2014)	Does participation in a summer STEM camp influence middle-level students' interest toward STEM content and STEM careers?	LEGO robotics, programming, engineering design, aerospace, sustainability, mathematical modeling, and astronomy for 5th through 8th grade underrepresented (females and students of color) students	5 days with 7 hours each day 35 contact hours	All participants reported significant positive change in "having an interest in a STEM career field." Many positive testimonials on attending the program. N = 192
Nugent et al. (2010)	Examine the impact of robotics and geospatial technologies interventions on youth's learning and attitudes toward STEM	Building and programming robots with LEGO Mindstorm Robotics and with handheld GPS receivers and ArcMap GIS software for middle school youth	2 programs described; 1-week summer camp and half-day event Approximately 3 contact hours for half-day event and approximate 40 contact hours for summer camps	Increased student attitudes toward science, mathematics, robots and GPS/GIS. Only the weeklong intervention increased STEM learning of covered topics. Students in the half-day event had significant higher perceptions of the value of STEM N = 147

Phillips and Miller (2014)	Determine what influences a STEM career choice	Re-construction of a replica of a NASA spacecraft and other activities. Emphasized STEAM (Science, Technology, Engineering, Arts and Math) for 4th through 8th grade students	10 days with four hour sessions each day Approximately 40 contact hours	Older students (6th-8th grade) showed a significantly higher interest in STEM careers and female students also showed a significantly higher interest in STEM N = 38
Tangney et al. (2010)	Provide participants with deeper understanding of computing degrees and increase interest in pursuing computer-related area	Programming with Scratch for students age 15 and 16	3 ½ days during school Approximately 22 contact hours	The overall response to the workshop experience was significantly very positive N = 39
Tyler-Wood et al. (2012)	BUGS (Bringing Up Girls in Science) is designed to increase the participants' academic achievement in science	Environmental science to 4th and 5th grade females	10 days with four hour sessions each day Approximately 40 contact hours	BUGS participants had a significantly higher perception of science careers than non-BUGS participants N = 100
Van Delden and Yang (2014)	Influence participant interest in attend the home institution and study STEM	Java programming and robotics for middle and high school students	1-week summer camp Approximately 35 contact hours	No significant increase in interest in studying computer science or technology, or studying at the home institution N = 36
Wigal et al. (2002)	ACES (Adventures in Computers, Engineering, and Space) is designed to address the gender gap in engineering and computer science	Engineering and computer science for 7th & 8th grade females The program was followed up by a one-day session during the school year	1-week summer camp with single day school year follow-up Approximately 48 contact hours	Inconsistent information N = 24
Yilmaz et al. (2010)	Attract and motivate high school students and increase awareness to engineering fields	Engineering projects for Hispanic high school girls	1-week summer camp, Approximately 45 hours	Significantly increased satisfaction, self-confidence, and interest toward engineering N = 30

Table 1. **Summary of STEM Program Attributes**

3. COMPARING TWO MODELS

Lacking measurable data on costs and program outcomes, STEM program creators are ill-equipped to present viable return-on-investment (ROI) business cases for continuing their programs. While this situation may be acceptable for new initiatives, funding authorities are more likely to provide ongoing support for programs that can present ROI data along with demonstrable and measurable program successes.

Our comparison examines two model programs or interventions that were engineered to attract diverse students. Both options are predicated on stimulating interest in STEM, on enhancing knowledge of information technology-related STEM career paths, and on motivating to pursue information technology-related STEM studies. We also sought to complement university diversity objectives by expanding the number of underrepresented college applicants capable of succeeding in an information technology program. All the middle and high school students that participated met the university's and the NSF's diversity goals for first generation college students, women, African Americans, and Hispanics.

The Multi-Day program was created first and was developed to spur an interest in STEM (specifically computer information systems) and to increase the number of diverse students motivated to study information technologies. After five years, the Single-Day program was developed and operated in parallel with the Multi-Day model in an effort to serve more students. Both models combined information technology hands-on learning experiences, opportunities to experience life as a college student, and information necessary to apply for and succeed in college. Both models included mentorship and engagement with existing university students. Table 2 contrasts the two models. A sample description of a STEM experience is included in the Appendix.

Logistics/Overview:	**Multi-Day Model**	**Single-Day Model**
Student Participant Selection	School Teachers Select Individual Participants	School Teachers Select Entire Classrooms
Timing of Sessions	June (Summer Semester)	During Academic Year
Number of Sessions	1	4
Students per Session	40-50	40-50
College Student Mentors	8	4
On-Campus Time commitment	4 days: 2 full, 2 half days	1 day
Cost/Student–lodging	$85	$0
Cost/Student – meals/snacks	$82	$9
Cost/Student – supplies	$50	$12
Total Tangible Costs per Attendee	$217	$21
Intangible Costs – people, facilities, space, etc.	Student Peers = 192 hours Classrooms/Labs = 4 days	Student Peers = 24 hours Classrooms/Labs = 1 day
Student Participants:		
Time Spent on Campus	4 days – 2 full, 2 half days	1 day
Contact Hours	36 hours	5 hours
STEM Experiences	8	2
College Prep Experiences	2	1
Interactions with Deans & VPs	4	1
Campus Tour	Yes	Yes
On Campus Meals	9	1
Staffing		
Faculty Time to Deliver Program	32 hours	5.5 hours
Faculty Time to Administer Program	50 hours	6 hours

Table 2 – Contrasting the Investment for each Model

Consistent with our goal to evaluate alternative models using the Return on Investment framework, Table 2 reports on the tangible and intangible costs for each model. Readers will note that the tangible costs for the multi-day model are ten times those for the single-day model, and the intangible costs for the multi-day model are four times those for the single-day model.

Examples of some of the intangible cost that are difficult to capture include the professional talent used to staff sessions, facilitate learning activities and administer the programs. Based upon the available literature, this is an often neglected aspect of data collection and reporting. As shown in the review of literature, only Demetry et al.'s (2009) study clearly reported the annual cost of the summer program.

4. METHODOLOGY

Our samples were drawn by first selecting public and private target schools based on each school's diversity makeup. Diversity data was obtained from the university's admissions office, who regularly maintains this data for recruitment purposes. Administrators at targeted schools were contacted to identify potential information technology and STEM teachers. These teachers were contacted and invited to participate in the intervention programs. There were no costs to participate. Our intervention programs provided transportation, meals, and lodging as required. There was not a selection process for individual student participants; instead, students were selected by the participating teacher, who was provided the diversity objectives for the program. Student participants included all races, multiple nationalities, both genders, various income levels, and came primarily from homes where one or both parents had not attended college.

To determine the outcomes of the two STEM programs, pre- and post-surveys were completed by 76 student attendees (38 for the multi-day program and 38 for the single-day program). The pre- and post-survey contained four questions listed below. Each question had a progressive scale where the number one (1) represented "none" or "not at all" ranging up to the number five (5) that represented "I know…" or "I definitely am." The survey questions appear below:

1. How much thought have you given about what you'll do once you graduate from high school?
2. What do you feel are the chances that you'll want to attend college?
3. Are you interested in having a career where understanding and using technology will be one of your primary skills?
4. Do you think that the sponsoring institution is a good place to study and learn about technology?

5. DATA ANALYSIS

Prior to data analysis, data were screened for normality. Checks for normality were performed for differences between the paired values. Skewness values less than the absolute value of 2 and kurtosis values less than the absolute value of 7 were considered normal. For post high school plans, skewness was 0.099 (SE = 0.285) and kurtosis was -0.623 (SE = 0.563). For interest in pursuing technology, skewness was 0.350 (SE = 0.287) and kurtosis was 0.906 (SE = 0.566) and attending the sponsoring university had a skewness of -0.218 (SE = 0.285) and a kurtosis of -0.484 (SE = 0.563). Both skewness and kurtosis appeared to be within the normal range (Thalheimer and Cook, 2002).

The analysis of the data from the pre- and post-tests for the four questions from each of the two samples included tests for normality and t-tests for matched pairs. Survey data from the Multi-Day and Single-Day STEM Program Models were compared to form the basis for understanding which of the two Program Models offered a higher return-on-investment (ROI) for the effort and funds expended. Results for each of the four survey questions are presented below; the single-day STEM program results are discussed first, followed by the multi-day program's results.

5.1 Post High School Plans

The single-day program was successful at encouraging attending participants to consider post high school options, (t = 2.074, df (34), p = 0.046, 95% CI [-0.735, -0.007]). The single-day program moved students from a mean of 4.06 to a mean of 4.43 with a Cohen's d of 0.48. Participating in a single-day STEM program had a medium effect on increasing interest in STEM, and may aid in positively affecting students' perceptions of post high school opportunities.

Similarly, the multi-day STEM program was successful at encouraging students to consider post high school options. The multi-day program moved students from a pre-test mean of 3.97 to a post-test mean of 4.44, which was statistically significant (t = 2.619, df (35), p = 0.013, 95% CI [-0.838, -0.106]). There was a medium effect with a Cohen's d of 0.58. Both programs successfully increased students' interest in STEM-related education.

5.2 Propensity to Attend College

Surprisingly, we found no significant differences for question number two; the chance that college is an option, for either program. When we closely examined the pre- and post-survey scores, both pre- and post-test means for the single-day program were high at 4.74 and were even higher for the multi-day program at 4.81 and 4.89. This outcome suggested that almost all the students in the sample responded with the already affirmative options on the survey. These two options were "I want to give college a try" or "I know that I'm going to college."

5.3 Interest in Pursuing a Technology-Focused Career

The results for question three on the pre- and post-test surveys were statistically significant for the single-day program (t=2.692, df (34), p = 0.011, 95% CI [-0.852, -0.119]). The single-day program was able to significantly move pre- and post-survey scores from a mean of 3.31 to a mean of 3.80 with a Cohen's d of 0.58, implying that a single-day program moved attending students from "possibly considering" an information systems-related college degree to "expecting to pursue" a career where understanding and using technology is a primary skill.

The multi-day program outcomes were not significant. In review of the data for question 3, the results of the survey were 4.03 and 4.09 for the pre- and post-test survey, respectively. Students attending the multi-day program were already "expecting to pursue" a career in STEM.

5.4 Attitude Towards Studying Technology at the Sponsoring Institution

Our Computer Information Systems (CIS) program would like to enhance the diversity of the program and increase the number of CIS majors. The program was designed to influence the students to consider the sponsoring institution in their future plans. Happily, the results showed significance. The single-day program successfully moved the mean score for "Do you think our institution is a good place to study and learn about technology" from 3.89 to 4.60 signifying a large effect with a Cohen's d of 0.95. This difference was significant (t=3.751, df (34), p = 0.001, 95% CI [-1.100, -0.327).

Outcomes of the multi-day program were very similar. Mean pre- and post-survey scores were 3.94 and 4.50 respectively, with Cohen's d of .725 and were significantly different (t=3.084, df (35), p = 0.004, 95% CI [-0.921, -0.190]). Considering the competitiveness of higher education within the region (within a two-hour drive of the participating students there are four community colleges, four state universities, and eleven private colleges/universities) we found this to be a positive outcome.

Previous statistical analyses compared only differences within samples; however, differences in change between the two samples may be due to the intervention or underlying differences between the two groups. Ideally, an analysis of covariance would be conducted to control for the pre-test scores; however, because pre-survey scores were measured using an interval level of measurement, assumptions to use a covariate were not met. Instead, to address the fact that the samples for the single-day program model and the multi-day program model were pulled from slightly different populations the difference between pre- and post-test scores (i.e., change scores) were calculated and n series of independent t-tests were performed to examine differences in the amount of attitudinal change for each intervention. The results indicated that no significant differences were apparent when "changes in attitude" results from the single and multi-day interventions were compared. This suggests that participants from each sample responded similarly to survey questions regarding changes in attitude.

In summary, we were unable to detect a discernible difference in the amount of change in students' attitude results for three of the four variables between the single- and multi-day models, even though the models differed greatly in the investment made.

6. DISCUSSION AND CONCLUSIONS

This study sought to determine whether ROI is a discriminating variable in the success of alternative models for delivering programs to diverse populations to stimulated interest in information technology careers and in the pursuit of information technology STEM-related degrees. The research indicates that both multi-day and single-day programs are capable of motivating students to pursue information technology STEM programs. However, the findings highlight that the level of motivation does not increase as program investments increase. The findings suggest that the single-day model is nearly as effective as the multi-day model at increasing students' interest to pursue information technology STEM related educational opportunities.

It is worth noting that for survey question number three, "Interest in pursuing a technology-focused career," there was a significant difference between the two models. We believe that this difference is attributable to a slight sample variance between the two interventions. The multi-day model required a larger time commitment by student participants. This may have attracted students with hire predispositions to pursuing STEM opportunities. In contrast, the single-day model was predicated on an entire classroom or a common-interest group of selected students attending. Arguably the single-day program had the potential to convert non-predisposed students to want to go to college and study STEM careers. Because of this inconsistency, this issue will be revisited in future research.

As discussed in the review of literature, there are variations in the design, sharing of program cost and investments, and assessment of outcome evaluation of existing STEM intervention programs. This limits the ability to compare programs and generalize program outcomes, especially from an ROI perspective. We recognize and encourage experimentation in the design of STEM intervention programs. However, good research practice requires consistency in assessment and outcome evaluation methods (Christensen, Knezek, and Tyler-Wood, 2011).

Creating interest in STEM careers and in the pursuit of STEM education/degrees is a long term undertaking, one in which there have been significant developments over the last decade. Few studies cited in our literature search covered multiple years (Tyler-Wood et al., 2012) and even fewer reported the true costs (Demetry et al., 2009).

There is a demonstrated lack of reporting on the investment, the "I" in the ROI, for tangible and intangible investments for intervention programs. While this data may be difficult to collect and report, the data is essential to be able to objectively evaluate alternative interventions and invest in those that make the most economic sense. This research suggests, albeit for a limited sample, that similar outcomes are obtainable at different investment levels. Good stewardship practices for selecting alternative intervention programs should include ROI as a discriminating consideration. Armed with this knowledge, designers will be motivated to collect and report cost data for their proposed STEM intervention programs.

This research has consolidated information about existing STEM program initiatives, categorized those initiatives based upon high-level attributes, and demonstrated that return on investment is an important variable to study when implementing interventions. Lastly, this research presents the rationale for tracking, reporting and utilizing cost data to be able to compare alternative intervention programs based on each program's ROI.

7. ACKNOWLEDGEMENTS

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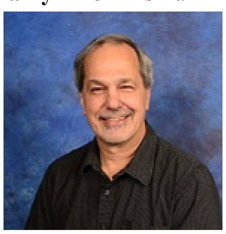

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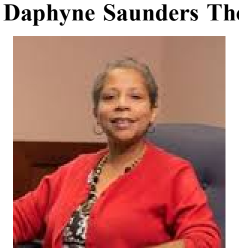

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APPENDIX

Creating a Mobile Phone Application Using MIT App Inventor 2

5 minutes: Introduce the instructor and lab assistants

5 minutes: Introduce the MIT App Inventor 2 Software and Website

15 minutes: Guided Activity of a sample application (BallBounce). Lead by instructor while lab assistants move around the room to assist.

5 minutes: Upload to Phone Activity with USB cables.

5 minutes: Introduction of object oriented programming with an interactive discussion using the BallBounce activity as an example.

5 minutes: Problem Solving Activities to modify objects.

- Change the color of the ball based on the speed
- Scale the speed of the ball so that it slows down and stops
- Give the ball obstacles or targets to hit

10 minutes: Guided Activity of a sample application (Hello Purr). Lead by instructor while lab assistants move around the room to assist.

5 minutes: Upload to Phone Activity with USB cables.

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