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Using Technology and Collaboration with STEM Professional to Enhance Students' Self-Efficacy and Interest in STEM

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Abstract

This paper highlights the year-one (pilot) findings of a three-year project on emerging technologies where students engaged in computer modeling, 3D printing, flight simulation, and drones during summer camps and afterschool programs in rural and urban districts. The pilot was iterative as different interventions were field-tested in specific environments. The purpose of the pilot study was to examine and refine the interventions and understand their influence on students' self-efficacy and interest in computing, science, and technology.

Aim: The goal of this study was to examine students' efficacy in computer programming, science and technology using Tinkercad, Sculptris, Flight Simulator X and DJI Mavic Pro Drones.

Problem

The expansion of school-based access to technology has led to the inclusion of technology into the curriculum of formal and informal learning environments. This has made it necessary for education stakeholders to identify tools, pedagogy and practices that promote learning with technology. This is particularly important for students of color who, studies show, are underrepresented in the STEM pipeline (Whittaker & Montgomery, 2012; Lyon, Jafri & St. Louis, 2012). The overemphasis on the negative factors that affect students of color, reinforces societal prejudices and stereotypes, distorts the achievements of those who persist despite various obstacles and social pressures (Shin, 2011; Franklin, 2004; Nicolas et al., 2008) and may lead to low academic self-efficacy. As such this study sought to answer the following questions;

1. How did the technological tools influence students' efficacy in computer programming?
2. How did the technological tools influence students' efficacy in science and technology?
3. What themes related to the technological tools emerged after the intervention during focus group interviews in Philadelphia?
4. What STEM disciplines or careers did afterschool students mention during focus group interviews in Philadelphia?

Research Study Design

The study was conducted in two different settings. Site 1 was in a rural location in Wyoming and site two was located in an urban Pennsylvania location. Study participants consisted of students from grades 5 through 8. This study engaged students in project-based learning experiences through computer modeling and 3D printing to provide them with coding experiences. Flight simulation and drones provided students with applications that allowed them to develop new knowledge and understandings of complex systems. Students learned about the forces of flight: lift, drag, thrust, and gravity. Students at both settings received 30 hours of intervention where they could play with TinkerCad and Scupltris computer modelling software and Flight Simulator X, and DJI Mavik Pro drones. Students were also

given projects to create models of items such as keychains using the Tinkercad and Sculptris software. Once they were satisfied with the models, they were allowed to print them using a 3-D printer.

Methods

Data was collected from two sources. First, surveys developed by Ketelhut and Jordan (2018) were used to assess students' self-efficacy and STEM interest. To address questions 1 and 2, the survey measured students' self-efficacy in computer programming, science and technology. The data were analyzed using paired sample *t*-tests to determine whether the interventions led to significant differences in students' self-efficacy. Qualitative data was collected at the site 2 in Pennsylvania via focus group interviews to assess students' attitudes about the program. The qualitative data was used to address questions 3 and 4. The constant comparative method (Strauss & Corbin, 1990) was used to find themes and patterns from the transcripts.

Findings and Discussion

Quantitative results showed that students at both sites had significant increases in their computer programming efficacies. This was attributed to high interests in using the computer modeling with Tinkercad, Sculptris and 3-D printing. The science efficacies at site 1 increased significantly but decreased at site 2. Qualitative data revealed that students enjoyed using the technological tools. The only negative comments were related to some younger students not getting to fly drones in Philadelphia. One student mentioned wanting to become a scientist or engineer. All the students identified specific parts the lesson presented by the STEM speaker. This indicates that the inclusion of the guest speaker increased the students' knowledge of science content although it did not increase their science efficacies.

Discussion

It could be that the students in site two did not consider learning about and using with technological tools to be associated with what scientists do.

Research Implications

The results from the pilot data reveal that having students engage in emerging technologies in an out-of-school program holds promise for impacting students' computer programming skills, engagement, self-efficacy and interest in STEM. Questions that remain are what elements of these interventions have the greatest impact on students? And how do we refine the intervention to increase positive outcomes? Some additional questions that emerged from the research include: did gender, race/ ethnicity, or local culture play a role in lower science efficacy scores? What factors led to increased technology efficacy and interest at Site 2? How did teachers' and STEM professionals' lessons influence these outcomes?

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Author Biography

Mikhail Miller is a PhD student in the School of Education whose focus is on STEM education. He is particularly interested in Mathematics and Engineering education. He currently works with Drs. Christopher Wright and Brigitte Valesey. Mikhail is originally from Jamaica but earned his bachelor's degree from Fisk University in Nashville Tennessee and master's degree from Tennessee State University. Prior to joining us at Drexel, Mikhail worked in multiple positions in the field of education starting out as a tutor for Mathematics and Physics while completing his undergraduate degree, to working as a substitute teacher at LEAD Academy in Nashville Tennessee. He was also the mathematics lab coordinator at his alma mater Fisk University. Mikhail's research interest includes, Black males in engineering education, math literacy, formal and informal learning, and representation of African American male identities in various levels of education. He is a proud member of PhD cohort 5.