Research Articles and Essays

Moving online: Transforming an Algebra Enrichment Program for Online Instruction and the Impacts on Student Learning Experiences and Outcomes

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Abstract

Article provides an overview of Project BEAM (BE A Mathematician) and its efforts to engage indigenous and Hispanic middle school students in algebra to increase their participation in gifted education programs, as well as facilitate their advancement to careers in STEM.

Keywords: STEM, Native Hawaiian Education, algebra, gifted education, online instruction, math

Despite considerable efforts by educators and researchers, Hispanics and indigenous groups of students such as Native Americans, Native Hawaiians, and Pacific Islanders continue to be significantly underrepresented in both K-12 gifted and talented education programs, as well as, in science, technology, engineering, and mathematics (STEM) college majors and careers (Landivar, 2013; Payne, 2011; Yoon & Gentry, 2009). Participation in gifted education math programs, such as successful completion of algebra in middle school, can open up opportunities to college programs and careers in STEM (Adelman, 2007; Satz,

2007). Algebra 1 is considered a "gatekeeper" course of the STEM pathway (Satz, 2007) since enrollment in advanced-level math and science courses are oftentimes contingent on the mastery of algebra (Jetter, 1993; Stoelinga & Lynn, 2013). Thus, it is critical to engage indigenous and Hispanic middle school students in algebra in order to increase their participation in gifted education programs, as well as facilitate their advancement to careers in STEM.

To provide such early opportunity and to research the effectiveness of providing a culturally responsive, accelerated, and enriched algebra intervention for Hispanic and indigenous middle school students, we have designed a program called Project BEAM (**BE A M**athematician). The BEAM Model consists of three main components: (1) hands-on, culturally responsive math activities; (2) real-world math exploration; and (3) math project development. The model uses the Renzulli Enrichment Triad Model (Renzulli, 1976) as a core structure to guide students through a progression of activities, beginning with general exploratory activities (Type I), continuing on towards developing problem solving and critical thinking skills (Type II), and culminating with an independent, real-world problem investigation study utilizing the processes of practicing professionals in their area of interest in order to produce advanced-level and creative products (Type III). In delivering the program to the students, we utilize an array of evidence-based teaching strategies (i.e., blended learning, ethnomathematics, differentiated instruction, and universal design for learning). So far, the model has been tested with 332 students from 24 middle schools across Hawai‘i, Arizona, and the Commonwealth of the Northern Marianas Islands.

Originally, the BEAM program was implemented as an in-person, after school or summer intensive math program. Due to school closures resulting from the COVID-19 pandemic, we modified and implemented BEAM math lessons and activities through

synchronous online sessions since March 2020. The purpose of the study is to describe how we transformed the math program for online instruction and compare student learning experiences and outcomes between the online math program with the original in-person math program and an online (non-math) English-Language Arts program.

In order to maintain the original program components, intensity, and quality as well as research design, we substituted activity materials for common household items. We created an online learning environment using Zoom to hold synchronous online sessions with breakout rooms for small group activities in addition to online learning management programs (i.e., Canvas and Google Classroom) for assessments and daily assignments. Transforming student worksheets and math games into Google Docs, Slides, and Sheets allowed project instructors to observe the students' problem-solving process and provide feedback in real time.

To compare the learning experiences and outcomes when students were exposed to two different learning environments (face-to-face vs. online), we used the data from in-person BEAM Summer 2019 math camp (n=28), online Summer 2020 math camp (n=71), and online Summer 2020 English Language Arts (ELA) camp (n=39). As a result of data analysis, despite the concerns regarding the virtual learning platform in fostering engagement and understanding among students, we found that the online math program made significantly more positive impacts on students' sense of excellence and responsibility, attitudes towards math, and engagement in math learning than the online non-math, ELA program. In turn, these positive attitudinal changes were translated into increased confidence in learning and solving algebra skills as well as improved algebra achievement. There wasn't a significant difference between the in-person and online math camps in those outcomes. Furthermore, the online math program students were as likely as in-person math group

students to view the math camp as fun and engaging. In part, this might be because project staff had fostered a supportive and engaging online learning environment in which students could interact with the teachers and, more importantly, their peers. These findings imply that online learning can provide quality math instruction, comparable to the in-person math instruction, when appropriate adjustments are made to assure students' engagement in learning.

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