Shifts in STEM Perceptions Based on an Immersive STEM Experience

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Introduction

The elements of science, technology, engineering, and mathematics have long been embedded, to varying degrees, within the structure and curriculum of school-based agricultural education (SBAE) for more than 100 years (Hillison, 1996). According to Dugger (2010), STEM is often defined as the integration of science, technology, engineering, and mathematics into a cross-disciplinary subject within school curricula. STEM education provides students with opportunities to understand the interconnected nature of the world, rather than acquiring isolated fragments of knowledge and practices (Dugger, 2010).

Agricultural careers demand increasingly sophisticated levels of STEM comprehension and application (Stubbs & Myers, 2016). Agricultural education provides an authentic platform for integrating and applying STEM concepts (Smith et al., 2015) in which previous research has consistently demonstrated that integrating scientific concepts into agricultural curricula is an effective method of science instruction. Students taught through agriculture–science integrated approaches achieve significantly higher outcomes than those receiving traditional, non-integrated instruction (Chiasson & Burnett, 2001; Enderlin, et al., 1993).

STEM education relies heavily on the pedagogical principles of project-based learning (PBL), and learning activities often involve guiding students through structured inquiry processes and engaging them in the creation of tangible outcomes. This approach is particularly well-suited to CTE, where practical application and skill development are emphasized, and is especially relevant in SBAE (Wannapiroon et al., 2021).

Theoretical Framework

This study was guided by Social Cognitive Theory (SCT; Bandura, 1986). SCT focuses on the impact of experiences shaping beliefs, attitudes, and perceptions through the ongoing interplay of personal, environmental, and behavioral factors (Bandura, 1986). Within this study, the experience related to the Agricultural Microbiome Program, an immersive STEM experience.

Purpose and Research Objective

The purpose of this study and overarching research objective was to determine the impact of the Agricultural Microbiome Program on students' perception of STEM.

Methods

A one-week summer camp was hosted at [University], which introduced ninth and tenth grade students ($N = 20$) to microbiome sciences and specific agricultural microbiome models using immersive STEM experiences. The Agricultural Microbiome Program (AMP) trained participants in techniques used to study microbiomes that can be applied to numerous science disciplines important to agriculture. The program participants were guided and trained on how to

develop outreach presentations and present complex science content to the public, and we evaluated the perceptions of their audiences.

This study employed a one-group quasi-experimental design (Privitera, 2020) to examine changes in participants' STEM perceptions before and after a week immersive camp and after their public presentation. Participants' perceptions of STEM were assessed using a semantic differential scale to indicate how they feel. The instrument consisted of 10 adjective pairs rated on a 7-point scale. Data was analyzed using SPSS version 29. Descriptive statistics (i.e., mean and standard deviation) were used to summarize the data, while a repeated measures ANOVA was used to test whether there were significant differences in mean perception scores across the three time points (pretest, posttest, and post-presentation).

Findings

Table 1 presents the descriptive statistics and the ANOVA results, which indicated a statistically significant difference over time for science, technology, engineering, and mathematics perceptions, while perceptions of STEM careers did not significantly differ across time points. Partial eta squared values indicate moderate to large effect sizes for changes in science, technology, and engineering perceptions.

Table 1

Participants' Mean Scores

Construct	Pre-Camp		Post-Camp		Post-Presentation		*f*	*p*	*η2*
	M	*SD*	*M*	*SD*	*M*	*SD*			
Science	3.72	0.52	3.82	0.51	6.09	0.98	62.37	< .01**	0.72
Technology	3.92	0.31	3.74	0.40	4.36	0.98	46.05	< .01**	0.65
Engineering	3.70	0.38	4.00	0.75	5.40	1.10	22.69	< .01**	0.48
Math	3.92	0.95	4.13	0.76	5.00	1.49	4.77	<.05*	0.16
STEM Careers	5.63	1.21	5.73	1.30	5.78	1.27	0.33	>.05	0.13

Conclusions and Recommendations

Overall, participants' experiences in the STEM camp boosted their perceptions of science, technology, engineering, and math, but their views on STEM careers stayed largely unchanged, suggesting that ongoing, career-focused activities are needed to make long-term career changes. Post-hoc analysis resulted in the greatest mean scores at the post-presentation point for science, technology, engineering, and mathematics, suggesting that continued engagement or reflection after the camp further reinforced positive perceptions, rather than leveling off immediately after the camp. Future studies should include a comparison or control group to strengthen causal inferences, and longitudinal research should be done to examine whether perception changes persist beyond the immediate post-presentation phase.

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