INFLUENCE OF INTEGRATED STEM CURRICULA ON ELEMENTARY STUDENTS' STEM SELF-EFFICACY

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Rationale

- Research has demonstrated the importance of including STEM education in elementary schools (Dringenberg, Wiener, Groh, & Purzer, 2012).
- Young kids are initially interested in mathematics and science, but they lose interest as they progress through school, especially among females (Sadler, Sonner, Hazari, & Tai, 2012).
- Beliefs about one's competence, interests, and attitudes, known as self-efficacy, about STEM plays a role in his/her likelihood to pursue a STEM career (Wang & Degol, 2017).

Research Question

What is the effect of an integrated STEM curriculum on fourth-grade students' STEM self-efficacy?

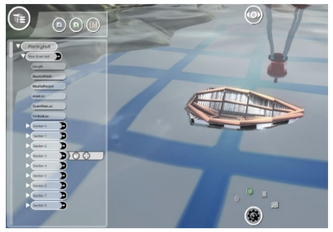
Is there a difference on how an integrated STEM curriculum affects the STEM self-efficacy of male and female fourth-grade students?

Literature Review

- Self-efficacy is the belief in one's ability to successfully perform a task or be successful in a particular situation (Woodruff & Cashman, 1993).
- Self-efficacy is an important predictor of motivation and performance (Rittmayer & Beier, 2009).
- Those with high STEM self-efficacy tend to perform better and persist longer than those with low self-efficacy (Rittmayer & Beier, 2009).
- STEM self-efficacy influences interests, goals, and career choice and is positively related to engagement in STEM (Rittmayer & Beier, 2009).

DESCARTES Curriculum

DESCARTES is an integrated STEM curriculum in which students solve a real world challenge (shipping cargo efficiently across a body of water) that is embedded in an authentic context (designing and building boats). Students are presented with an overarching challenge – design and build a boat that can carry a given amount of load across a body of water within a set amount of time. Throughout the unit, students participate in a variety of hands-on, inquiry-based activities to understand and test concepts such as density, buoyancy, pressure, water displacement, and volume. Students also engage in the DESCARTES software environment in which students collaborate with one another as they engage in virtual prototyping and simulations that test similar factors that they learned in the hands-on lessons.



Methods

Participants

Fourth-grade students across three different classrooms at a public elementary school in the midwestern United States participated in the study during the Fall of 2019. The final sample of students (N = 51) included in this analysis was predominantly White (96%) and had only a slight majority of female students (51%) than male (49%).

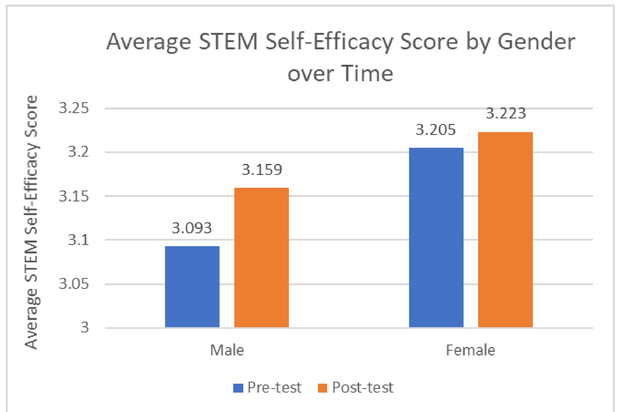
Data

Students completed a 46-item self-reported survey gathering information related to STEM experiences, interest in STEM, and STEM self-efficacy before and after participating in the DESCARTES curriculum. In the survey, 38 four-point (1 to 4) Likert scale questions measured STEM self-efficacy. Lower scores indicate a lower level of STEM self-efficacy while higher scores indicate a higher level of STEM self-efficacy.

Analysis

A two-way mixed-design ANOVA was used to analyze students' mean score of the survey responses to the 38 Likert-scale items. Students were excluded from the analysis if they did not respond to two or more of the 38 items on both the pre-test and post-test, resulting in a valid sample of 51 students.

Results



- There was no statistically significant interaction between gender and time on STEM self-efficacy, $F(1, 49) = 0.292$, $p > .05$, partial $\eta^2 = .006$.
- The main effect of time did not show a statistically significant difference in mean STEM self-efficacy at the different time points, $F(1, 49) = 0.858$, $p > .05$, partial $\eta^2 = .017$.
- The main effect of gender of student did not show a statistically significant difference in mean STEM self-efficacy across gender of student, $F(1, 49) = 0.615$, $p > .05$, partial $\eta^2 = .012$.

Discussion

- The integrated STEM curriculum did not have a statistically significant effect on fourth-grade students' STEM self-efficacy. This contradicts findings from a previous study showing a significant increase in the STEM self-efficacy of middle school students after engaging in a STEM curriculum (Brown, Concannon, Marx, Donaldson, and Black, 2016).
- There was no statistically significant difference on how the integrated STEM unit affects the STEM self-efficacy of male and female fourth-grade students. This is consistent with the findings of Brown et al. (2016) in which no significant differences were found between the self-efficacy beliefs of middle school male and female students.
- Despite these results, it is important to note that DESCARTES had no significant *negative* effect on students' STEM self-efficacy. The data did reveal slight increases in STEM self-efficacy, although it was not statistically significant, suggesting the value in continued efforts and evaluation.
- Potential limitations of this study include a potential *ceiling effect* (on the pre-test the average STEM self-efficacy score overall was 3.149 on a scale from 1(low self-efficacy) to 4 (high self-efficacy)) and the length of time students were engaged in the STEM unit (about 5 weeks).
- Future research could explore the effect of a longer integrated STEM curriculum on STEM self-efficacy with more diverse populations. Also, a mixed methods study may shed light on why significant results were not found and guide future integrated STEM research and curriculum development.

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