Undergraduate Students' Mathematics Efficacy Change through Collaborative Projects in General Education Mathematics Course

Jinsook Park
University of Hartford

Keywords: Collaborative learning, General education mathematics, Mathematics efficacy

Some challenges of teaching General Education Mathematics Courses (GEMC) motivated us to investigate how doing collaborative projects affects undergraduate students' self-efficacy in mathematics. The problems we see in the GEMC include students' low self-efficacy in mathematics, low engagement, and negative attitudes toward mathematics. Many students in GEMC described mathematics as a challenging subject area and a mixture of formulas and intense calculation, not recognizing the close connection with real-life. The need to improve the student success rate in GEMC is pervasive (Aycaster, 2001; Harrington et al., 2016; Thiel et al., 2008). These issues led us to questions about changing these low and negatives to higher and positive. In addition to achieving the specific student learning outcomes, three main goals in our teaching include 1) promoting student self-efficacy, 2) boosting student engagement in mathematics, and 3) fostering students' recognition of the relevance of mathematics in the real world. Several research studies have presented that project-based approaches worked positively for students' academic achievement and interest (Han et al., 2015; Jacques, 2017; Larmer & Mergendoller & Boss, 2015; Lou et al., 2012; Remijan, 2017; Rice & Shannon, 2016; Tseng et al., 2013). We added two collaborative projects in Math 1004 (pseudonym), one of the GEMC, to get students more engaged and constructing their meaning in learning.

Five elements were considered in implementing the collaborative projects in Math 1004: 1) own team decision, 2) own topic decision, 3) online shared documentation, 4) presentation together, and 5) peer evaluation. Students could learn technical competency, communication, presentation skills, and mathematical content knowledge throughout this process. Students could develop competency in identifying the problems in the real world and how to present the issues related to the problem and demonstrate techniques.

To explore any change in students' mathematics self-efficacy and recognition of mathematics relevance in real life, the pre-and post-surveys were given in the two sections of the Math 1004 course in the fall of 2021. There were 22 participants in both the pre-survey and the post-survey. In the survey forms, students were asked to mark one of the Likert scales: Strong Disagree, Disagree, Not Sure, Agree, Strongly Agree.

In summary, the results of this pre-survey and post-survey presented a positive change in the participants' self-efficacy in applying mathematical knowledge, problem-solving and explanation quantitatively, mathematical interpretation, and writing ideas quantitively. The findings through these students' positive changes include the following: 1) The participants anticipated the relevance of mathematics in real life through collaborative projects in the GEMC. 2) The participants showed positive change related to efficacy in mathematics after completing the collaborative projects in GEMC.

It is necessary to understand better how collaborative learning approaches work related to students' efficacy in mathematics. Knowing more about what students value in their experiences of learning mathematics through a collaborative learning approach is essential for instructors to develop instructional strategies for positive outcomes in learning.

References

Aycaster, P. W. (2001). Factors impacting success in community college developmental mathematics courses and subsequent courses. *Community College Journal of Research & Practice*, *25*(5–6), 403–416.

Han, S., Capraro, R., & Capraro, M. M. (2015). How science, technology, engineering, and mathematics (STEM) project-based learning (PBL) affects high, middle, and low achievers differently: The impact of student factors on achievement. *International Journal of Science and Mathematics Education*, *13*, 1089–1113.

Harrington, M. A., Lloyd, A., Smolinski, T., & Shahin, M. (2016). Closing the gap: First year success in college mathematics at an HBCU. *Journal of the Scholarship of Teaching and Learning*, *16*(5), 92-106.

Holmes, V. L., & Hwang, Y. (2016). Exploring the effects of project-based learning in secondary mathematics education. *The Journal of Educational Research, 109*(5), 449–463.

Jacques, L. A. (2017). What does project-based learning (PBL) look like in the mathematics classroom? *American Journal of Educational Research*, *5*(4), 428-433.

Larmer, J., Mergendoller, J., & Boss, S. (2015). *Setting the standard for project-based learning*. Association for Supervision and Curriculum Development.

Lou, S. J., Chung, C. C., Dzan, W. Y., & Shih, R. C. (2012). Construction of a creative instructional design model using blended, project-based learning for college students. *Creative Education*, *3*(7), 1281–1290.

Remijan, K. W. (2017). Project-based learning and design-focused projects to motivate secondary mathematics students. *Interdisciplinary Journal of Problem-Based Learning*, *11*(1).

Rice, M., Shannon, L. Y. (2016). Developing project-based learning, integrated courses from two different colleges at an institution of higher education: An overview of the processes, challenges, and lessons learned. *Information Systems Education Journal, 14*(3), 55-62.

Tseng, K. H., Chang, C. C., Lou, S. J., & Chen, W. P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PBL) environment. *International Journal of Technology and Design Education*, *23*, 87-102.

Thiel, T., Peterman, S., & Brown, M. (2008). Addressing the crisis in college mathematics: Designing courses for student success. *Change: The Magazine of Higher Learning*, *40*(4), 44-49.

Undergraduate Students' Mathematics Efficacy Change through Collaborative Projects in General Education Mathematics Course

Jinsook Park, Department of Mathematics, University of Hartford

UNIVERSITY OF HARTFORD

Introduction

General Education Mathematics (GEM)

- Quantitative Literacy (Association of American Colleges and Universities, 2005; Bennett et al, 2008; Steen, 2004)
- Students Failing in GEM (Aycaster, 2001; Harrington et al., 2016; Thiel et al., 2008)
- Students are less confident in mathematics (Ellis et al., 2016; Hall & Ponton, 2005; Hill et al., 2010; Sadler & Sonnert, 2017).
- Mathematics is frustrating (Hoyles, 2016; Riegel, 2021).

Motivation

Issues Noticed in My Teaching Experiences

- Low self-efficacy in doing mathematics
- Low engagement
- Low interaction
- Difficulty in developing written communication summaries after/during their verbal discussion.
- Difficulty making the task align with other elements such as context and purposes.

Change in My Teaching

- Provide more meaningful learning opportunities for students to have a more positive orientation towards mathematics.
- Collaborative Projects in GEM

Elements Considered in the Implementation of Collaborative Projects

- Students' own team decision
- Students' own topic decision
- Online shared documentation to progress-check
- Presentation together
- Peer evaluation

Method

Ontological Assumptions

- "Realities are multiple, constructed, and holistic" (Lincoln & Guba, 1985, p. 35).
- Each student's experience constructs their reality, which is related to their learning.
- "Knowledge is constructed by learners as they attempt to make sense of their experiences" (Driscoll, 2000, p. 376).

Research Question

- How do students change in efficacy in mathematics through collaborative projects in the General Education Mathematics course?

Data Collection

- We added two collaborative projects in Math 1004 (pseudonym), one of the GMC.
- Pre-survey and post-survey were given in two sections of the Math 1004 courses in the fall of 2001.
- There were 22 participants in both the pre-survey and the post survey.
- In the Survey forms, students were asked to mark one of the Likert scales: Strongly Disagree, Disagree, Not Sure, Agree, Strongly Agree.

Results

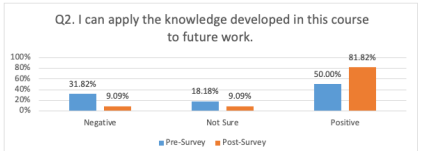


Figure 1: Students' self-efficacy change in applying mathematical knowledge in pre-survey and post-survey.

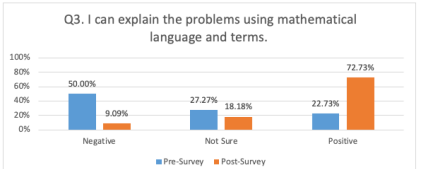


Figure 2: Students' self-efficacy change in problem-solving and explanation mathematically.

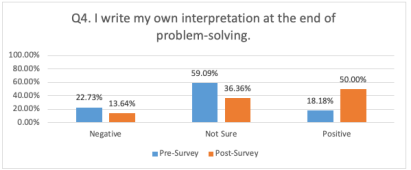


Figure 3: Students' self-efficacy changes in interpretation after mathematical problem-solving.

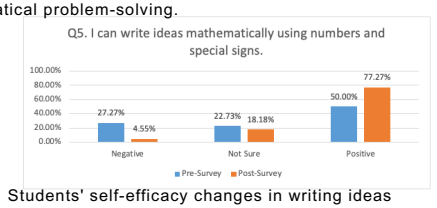
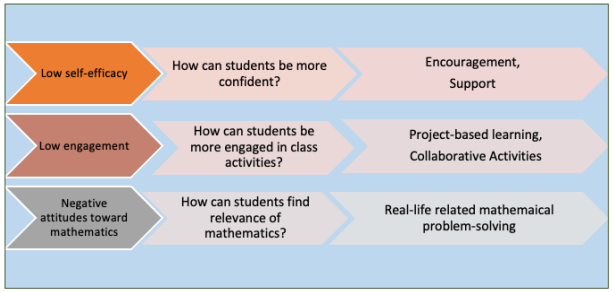


Figure 4: Students' self-efficacy changes in writing ideas mathematically.

The participants showed positive change related to efficacy in mathematics after completing the collaborative projects in GEM.

Discussions

- The participants anticipated the relevance of mathematics in real life through collaborative projects in the GEM.
- The students interacted more actively and constructively during class and outside class.



- Knowing more about what students value in their experiences of learning mathematics through a collaborative learning approach is essential for instructors to develop instructional strategies for positive outcomes in learning.

Acknowledgments: This research was supported by a Davis Fellows Grant from the University of Hartford. The views expressed here are those of the author and do not necessarily reflect those of the University of Hartford.