

The influence of consecutive flipped learning courses on students' math anxieties

Anthony Dove, PhD

Radford University

adove3@radford.edu

High quality mathematics teaching is necessary at all levels of education to create strong mathematically able students. Unfortunately, many elementary education teachers and preservice teachers have an anxiety towards mathematics that can impact their efficacy of teaching mathematics (Swars, Daane, & Giesen, 2010). This can have a negative impact on the learning of the students whom they teach and cause their students to begin forming mathematics anxieties (Ramirez et al., 2013). Research has suggested that mathematics courses that integrate student-centered instructional practices discussed in the *Principles to Action* (2014) can have a positive influence on improving students mathematics anxieties, anxieties about teaching math, and teaching efficacy (Utley, Moseley, & Bryant, 2005; Jansen et al., 2012).

One instructional practice that has the potential to decrease students' mathematics anxieties and assist mathematics teachers in creating a more student-centered class has been the flipped learning approach (Dove, 2015). At its core, flipped learning emphasizes shifting aspects of the learning environment that are teacher-centered to outside of class so that more time in class can be utilized for student-centered activities (Dove & Dove, 2015a). For example, a lecture-oriented teacher may create a shorter lecture video watched outside of class while having students practice, collaborate, and expand their content knowledge through more diverse activities. A project-based teacher may use multimedia outside of the class to provide a primer or demonstration that sets up the upcoming project to limit time lost in class when students need the most help. Research has suggested that flipped learning can help to improve students anxieties of mathematics and teaching mathematics (Dove, 2015), engagement in mathematics (Butt, 2014; Johnson, 2013), and achievement in mathematics (Dove & Dove, 2015b; Wilson, 2013).

Although research has shown positive effects, there has been limited research on the long-term influence of taking multiple flipped courses. The purpose of this study was to examine whether taking consecutive flipped mathematics courses for elementary preservice teachers may influence students' anxieties, attitudes, and beliefs about learning mathematics compared to students who had not taken a flipped course. Specifically, this study examined the following questions:

- 1) What influence does taking consecutive flipped mathematics courses have on students' math anxiety and anxiety about teaching math?
- 2) What influence does taking consecutive flipped mathematics courses have on interest in taking future flipped courses?
- 3) How does taking consecutive flipped mathematics courses influence students' perceptions of teaching and learning mathematics?

Methods

This study was conducted with two sections of the second mathematics course in a three-course series for elementary education preservice teachers at a mid-sized public university. This course emphasized fundamental concepts in geometry, measurement, data analysis, and probability. As the focus of this study was on the influence of students taking consecutive flipped courses, both classes were taught as similar as possible. Both sections were taught by the same instructor, which allowed for course requirements, expectations, and assessments to remain identical. The classes were taught three days a week for 50 minutes. Both classes were structured similarly. Students watched 1-2 instructor-created lecture videos around the content for the upcoming

lesson. They were required to take notes on the videos, which were checked. Class began with a warm-up related to the lecture videos as the instructor checked notes and homework completion. Afterward, the teacher reviewed the warm-up and answered any questions related to the homework or lecture videos. This would take approximately 10 minutes. The remainder of class, approximately 40 minutes, focused on utilizing student-centered, collaborative practice problems and extension activities. Physical and virtual manipulatives, computer programs such as *Geogebra* and *Excel*, and real-world situations were used whenever possible.

To determine the influence of consecutive flipped mathematics courses on anxiety, students completed the Mathematics Anxiety Rating Scale Revised (MARS-R) (Hopko, 2003) and the Anxiety about Teaching Math Scale (ATMS) (Hadley and Doward, 2011) surveys at the beginning and end of the semester. Pre-/Post-course surveys were paired for each student. As part of the pre-course survey, students were asked to state their previous instructor. Since only one professor had flipped the first course in the series, the students' data was categorized as either Consecutive Flipped (CF) or No Flipped (NF) experience. The CF had 22 pairs (71%) on the MARS-R and ATMS. The NF had 26 pairs (68%) on the MARS-R and ATMS.

Difference scores were calculated for each student by subtracting the pre-course anxiety score from the post-course anxiety score for each survey. This indicated that a negative score related to a decrease in a student's anxiety on the particular measure. Independent samples t-tests were conducted using the mean difference scores for each measure to examine whether students' previous instruction influenced the mean change in mathematics anxiety and anxiety about teaching mathematics.

The post-course survey also included six additional questions. Two questions asked students to rate their likelihood of taking another flipped course or recommending a flipped course to friend using a Likert scale from 1 (Very Unlikely) to 5 (Very Likely). This was used to assess students' perceptions of the flipped learning method as an instructional practice. Independent samples t-tests were conducted to determine whether previous instructional experiences influenced the potential to take future flipped courses and recommend flipped courses to their peers.

Finally, four open-ended questions asked students how the course had influenced their anxiety towards mathematics, anxiety towards teaching mathematics, potential changes in the course to assist with these anxieties, and any additional comments about the course or the instructional approach. Thematic analysis was conducted to discover common themes between the two groups and compare students' perceptions from each group around each theme.

Results

Math Anxiety and Anxiety about Teaching Math

Independent samples t-tests were conducted between the CF and NF to examine the mean change scores for the MARS-R and ATMS surveys. Results found significantly greater decreases for general mathematics anxiety by the CF group, but no significant difference in anxiety about teaching mathematics between the two groups (Table 1). Interestingly, while the mean score decreased for the CF on both the survey scales, the NF mean score increased for both measures. It is unclear what may have led to the mean increase in survey scores for the NF as students'

open-ended responses generally discussed the positive influence of the course on decreasing their anxieties (Table 3 and Table 4).

Table 1
Comparison of Average Change in Scores on the MARS-R and ATMS Surveys

	Group		<i>t</i>	<i>df</i>
	Consecutive Flipped Classes	No Flipped Class Experience		
MARS-R	-4.1(7.1)	1.3(9.3)	-2.24*	46
ATMS	-0.6(8.2)	1.8(15.3)	-0.67	45

*Note: *p = 0.05. Standard Deviations appear in parenthesis*

Interest in Future Flipped Courses

Independent samples t-tests were conducted to examine whether students would consider taking flipped courses in the future and recommend flipped courses to their peers. Results found no significant differences between the two groups in either area (Table 2). With scores above 3 on the Likert Scale for both groups, this suggests that students in general found this method to be a worthwhile instructional practice for a mathematics course. While not significantly different, the higher mean score on both questions by the CF does suggest the need for further examination as to whether continued use of the flipped learning method may impact students' preference towards its use for additional mathematics courses.

Table 2
Comparison of Likelihood to Take and Recommend Flipped Math Classes

	Group		<i>t</i>	<i>df</i>
	Consecutive Flipped Classes	No Flipped Class Experience		
Take another Flipped Math Class	4.0(1.3)	3.6(1.6)	0.93	47
Recommend a Flipped Math Class to a Peer	4.0(1.3)	3.6(1.5)	0.83	47

Note: Standard Deviations appear in parenthesis

Perceptions of Learning

Thematic analysis was performed on students' responses to the four open-ended questions. The analysis created two primary themes: Issues of Anxiety and Classroom Instruction.

Issues of Anxiety

Two open-ended questions asked about the influence of the course on general mathematics anxiety (Table 3) and anxiety about teaching mathematics (Table 4). Interestingly, while the CF was normally split on each question as whether the course positively influenced or had no influence on each anxiety, the NF had almost twice as many students make comments about how

the course positively influenced their anxieties. This is especially interesting when compared with the MARS-R and ATMS survey results. Students that felt a positive influence often discussed an increased confidence, comfort, and understanding of the geometry, probability, and statistics. For example, one student stated, “Even though I don’t like geometry, this class really has helped me feel more secure in my math abilities.” Those that felt no influence was achieved either stated, “No” or mentioned not feeling that they have mathematics anxiety. The students that suggested that the course created a negative influence all mentioned an aversion to the flipped learning approach. As one student stated, “I feel like I have more anxiety because I did not learn as much due to taking the notes online.”

Table 3

Do you feel that completion of this course has influenced any anxiety you have toward math? If so, how?

	Positive Influence	Negative Influence	No Influence	No Response	Total
Consecutive Flipped Classes	9	0	9	6	24
No Flipped Class Experience	16	1	7	4	28

Table 4

Do you feel that completion of this course has influenced any anxiety you have toward teaching elementary math? If so, how?

	Positive Influence	Negative Influence	No Influence	No Response	Total
Consecutive Flipped Classes	7	2	7	8	24
No Flipped Class Experience	13	3	6	6	28

Classroom Instruction

The concept of the instructional practices was discussed by students in all open-ended questions, but was most prominent in the third question (Table 5). Most students felt that the overall instructional practice related to flipped learning was beneficial to their learning. Students discussed in-class opportunities for hands-on learning, additional time for practice and collaboration, and a positive pairing of lecture video material with the class activities. As one student stated, “I’d like to be able to use some of [the instructor’s] teaching methods in my own classroom someday.” Several students also mentioned that the lecture videos were helpful due to the ability to pause, rewind, re-watch, and be viewed anytime. As another student mentioned, “I absolutely love the approach. I am a sickly person and having notes and videos online made staying caught up a lot easier. Also this class was very interactive.”

While a substantial number of students who had a positive response to the flipped class, there were several students with a negative reaction to the method, especially in the NF group. Specifically, these students did not feel they were learning from the lecture videos. For these students, the expectation of coming with a content base to expand upon through class activities

was frustrating and at times overwhelming. As one student stated, “I do not like the ‘flipped’ version of this course at all. I feel as though everything was extremely rushed, and I was not able to fully obtain the information I needed because it was never reviewed in class.” This is very different than many mathematics courses, because much of the learning process is done through engagement and wrestling with content in a manner not experienced before. As one student commented about the flipped class, “It is completely on the students.”

Table 5

Is there anything else you would like to say about the course or its teaching approach?

	Positive Influence	Negative Influence	No Response	Total
Consecutive Flipped Classes	16	1	7	24
No Flipped Class Experience	13	5	10	28

Discussion

This study provided an opportunity to examine whether taking consecutive flipped mathematics classes had a differing influence on students’ mathematics anxieties, their perceptions of their anxieties, and their perceptions about learning in a flipped class. While the CF students had a significant decrease in mathematics anxiety compared to the NF students, open-ended responses found that a substantial number of NF felt the course had positively influenced their mathematics anxieties. While open-ended responses did provide a positive trend towards flipped learning for both groups, participation in consecutive flipped courses may continue to assist with the decrease in anxieties and provide a more long-term enhanced perception of teaching and learning of mathematics.

Additionally, students from both groups were likely to take more flipped courses and recommend flipped courses, suggesting that most felt the method was a positive teaching method overall. Open-ended responses reinforced this perspective as students from both groups discussed the positive learning opportunities afforded by the flipped class, from being able to review videos at any time to the chance to be actively engaged throughout class. This supports students’ perceptions of flipped learning in previous studies (Dove & Dove, 2015b; Johnson 2013).

Of the NF students who did not prefer flipped learning, all five had the same instructor who taught the current course for the previous mathematics course. However, their previous course was not flipped. It is hypothesized that these students may have had a perception of how the instructor taught and what to expect from his course. Having these expectations altered may have intensified their dislike and unease of the flipped class. More research is needed to examine how previous learning experiences impact students’ perceptions of learning and future academic success.

References

- Dove, A. (April 13, 2015). *Flipping students' mathematics anxieties*. Paper presentation National Council of Teachers of Mathematics 2015 Research Conference, Boston, MA.
- Dove, A. & Dove E. (2015a). Flipped mathematics classroom: What? Why? & How? *Virginia Mathematics Teacher*, 42(1), 36 – 40.
- Dove, A. & Dove, E. (2015b). Examining the influence of a flipped mathematics course on preservice elementary teachers' mathematics anxiety and achievement. *Research Journal of Mathematics & Technology*, 4(2), 48 – 62.
- Butt, A. (2014). Student view on the use of the flipped classroom approach: Evidence from Australia. *Business Education & Accreditation*, 6(1), 33 – 41.
- Hadley, K. M., & Dorward, J. (2011). The relationship among elementary teachers' mathematics anxiety, mathematics instructional practices, and student mathematics achievement. *Journal of Curriculum and Instruction*, 5(2), 27-44.
- Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. M. (2013). *A review of flipped learning*. Retrieved from http://www.flippedlearning.org/cms/lib07/VA01923112/Centricity/Domain/41/LitReview_FlippedLearning.pdf
- Hopko, D. R. (2003). Confirmatory factor analysis of the mathematics anxiety rating scale - revised. *Educational and Psychological Measurement*, 63(2), 336-351.
- Jansen, B. R. J., Louwerse, J., Staatemeier, M., Van der Ven, S. H. G., Klinkenberg, S., & Van der Maas, H. L. J. (2012). The influence of experiencing success in math on math anxiety, perceived math competence, and math performance. *Learning and Individual Differences*, 24, 190 – 197.
- Johnson, G. B. (2013). *Student perceptions of the flipped classroom* [thesis]. Retrieved from https://circle.ubc.ca/bitstream/handle/2429/44070/ubc_2013_spring_johnson_graham.pdf?sequence=1
- National Council of Teachers of Mathematics (NCTM). (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM.
- Ramirez G., Gunderson E. A., Levine S. C., Beilock S. L. (in press). Math anxiety, working memory and math achievement in early elementary school. *Journal of Cognitive Development*, 14(2), 187-202.
- Swars S. L., Daane, C. J., & Giesen, J. (2010). Mathematics anxiety and mathematics teacher efficacy: What is the relationship in elementary preservice teachers? *School Science and Mathematics*, 106(7), 306 – 315.
- Utley, J., Moseley, C., & Bryant, R. (2005). Relationship between science and mathematics teaching efficacy of preservice elementary teachers. *School Science & Mathematics*, 105(2), 82-87.
- Wilson, S. G. (2013). The flipped class: A method to address the challenges of an undergraduate statistics course. *Teaching of Psychology*, 40, 193 – 199.