

Flipping Students' Mathematics Anxieties

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A challenge facing the preparation of highly qualified and effective teachers is the disproportionate number of elementary preservice teachers with math anxiety (Harper & Daane, 1998). High levels of math anxiety have been related to decreased perceptions of math ability and teaching efficacy (Swars et al., 2010). Once in the classroom, elementary teachers with high anxiety and low teaching efficacy have the potential to negatively influence their students' attitudes and achievement in mathematics, especially female students (Beilock et al., 2010). These negative experiences have the potential to persist and create a new cohort of highly anxious students that may eventually become math anxious elementary teachers (Bekdemir, 2010).

Although much research has been conducted to examine the contributing factors to math anxiety, there is limited research on the instructional practices and interventions for alleviating such worries. The research that does exist indicates that elementary preservice students' participation in methods courses that are student-centered, cognitively demanding, and build conceptual understanding can help decrease math anxiety and increase math teaching efficacy (Huinker & Madison, 1997; Tooke & Lindstrom, 1998). These instructional practices are not unfamiliar to math educators, as the *Principles to Action* (NCTM, 2014) support the use of such methods in all math classes. The utilization of these principles in more mathematics courses presents an opportunity to potentially create stronger elementary teachers and break the cycle of math anxiety.

The flipped classroom approach may provide a bridge to help professors include more student-centered practices in mathematics classes for preservice students. Bishop and Verleger (2013) define the flipped classroom as "an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom" (p. 6). Removal of the in-class lecture provides teachers with the opportunity to create a more flexible learning environment and shift the learning process toward the student (Hamden et al., 2013). Research has suggested that the flipped classroom approach allows for more opportunities to collaborate with other students (Dove, 2014; Johnson, 2013), and it can help improve students' self-efficacy (McLaughlin et al., 2013), engagement (Butt, 2014), and achievement (Fulton, 2012).

Although preliminary research has shown positive effects, there has not been consistency in the implementation of the flipped classroom. One area that has not been examined is how different instructional delivery methods within the flipped classroom may influence student outcomes. The purpose of this study was to begin examining differences in instructional delivery methods and their influence on students' math anxieties. This study examined the following questions:

- 1) What commonalities and differences occur in flipped classrooms using teacher created videos versus 3rd party videos?

- 2) What impact does different flipped classroom approaches have on students' math anxiety and anxiety about teaching math?

Methods

This study was conducted with two classes of a mathematics course for elementary education preservice teachers at a mid-sized public university. This course emphasized fundamental concepts in number and operations, algebra, and data analysis. Both classes 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, as a typical class included a warm-up, homework review, and discussion of the daily material/topic. The remainder of class focused on utilizing student-centered, collaborative practice problems and extension activities. Manipulatives, computer programs, and real-world situations were used whenever possible.

The difference between the two classes was the presentation of the instructional material. Class 1 (TF) was required to watch instructor-created lecture videos and bring notes to the following class. Class 2 (KF) was required to watch *Khan Academy* lecture videos and score an 80% on the corresponding challenge questions built into *Khan Academy's* sections.

To determine the commonalities and differences between the classes, two video observations were collected of each class. Each video was evaluated using the RTOP (Piburn et al., 2000) to determine if similar levels of reform teaching occurred in both classes. Raters were blind to whether they were watching videos of the TF or KF. Data was also collected from each video regarding the number of activities completed, time spent completing different instructional practices (review, instruction, activities), and qualitative description of teacher and student participation.

To determine the influence of the instruction 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 to measure any changes in mathematics anxiety and anxiety about teaching mathematics. The TF had 30 pairs (77%) for MARS-R and 30 pairs (77%) for ATMS. The KF had 28 pairs (72%) for MARS-R and 26 pairs (67%) for ATMS.

Results

Characteristics of the Classes

Inter-rater reliability between the two raters who evaluated observations was 80%. The average RTOP score for TF was 84, and KF was 86. MacIsaac and Falconer (2002) found that classes with RTOP scores over 50 showed strong signs of reform teaching, thus both the TF and KF classes had high levels of reform instruction occurring.

Additional analysis by the raters found several commonalities and differences between the two classes. For example, both classes completed the same number of activities during the observations. Both classes also spent about 25 minutes completing small group activities and 25

minutes in teacher-led large group discussions and activities. During small group activities, the instructor maintained comparable methods of scaffolding for students.

The most significant difference found was the amount of time spent reviewing lecture videos and assigned homework during the teacher-led instruction. While the KF spent an average of 8 minutes reviewing, the TF spent 2 minutes reviewing. The KF on average spent 6 minutes more in review than the TF had available to learn new material, which equates to about 252 minutes, or 5 classes, over the semester.

Math Anxiety and Anxiety about Teaching Math

Independent samples t-tests were conducted between the TF and KF to examine the mean change scores for the MARS-R and ATMS surveys. Results found significantly greater decreases for both forms of anxiety by the TF group (Table 1). This suggests that the flipped classroom instruction that utilized instructor-created videos had a greater overall influence on decreasing students' math anxieties than the approach that used 3rd party videos.

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

	Class		<i>t</i>	<i>df</i>
	Teacher Flipped Class	Khan Academy Flipped Class		
MARS-R	-7.8 (6.2)	-3.0 (8.0)	-2.58*	56
ATMS	-9.0 (10.9)	-0.8 (8.2)	-3.17**	54

*Note: *p = 0.05, **p < 0.01. Standard Deviations appear in parenthesis*

Discussion

This study compared different forms of instruction delivery in the flipped classroom and how each may have influenced students' math anxiety and anxiety about teaching math. RTOP scores suggested that both classes had high levels of reform teaching, which confirms that either instructional delivery method in the flipped classroom can provide the opportunity for high levels of student-centered instruction (Hamdan et al., 2013). However, some differences were found between the groups as the KF required more time to be spent reviewing homework and lecture material. Additionally, the TF had greater decreases on both math anxiety scales.

One possible reason for this significant difference may be that instructor-created videos provided consistency between the lecture videos and the in-class activities. This may have better assisted in establishing the mathematical goals that focus learning (NCTM, 2014). By directly aligning videos to each lesson, students may better understand the goals of the following class, the purpose of the different activities, and better monitor their progress of learning during class (Marzano, 2009). In contrast, the use of 3rd party videos require using the video that is most similar to the upcoming content, or even the use of multiple videos, thus the mathematical goals may not be as consistent or clear for students. This lack of consistency may have led to students requiring additional time to spent reviewing homework and lecture material.

The results of this study suggest that while the flipped classroom approach can provide an opportunity for enhancing the amount of time spent using instructional methods that align with *Principles to Action* (NCTM, 2014), careful consideration should be taken into the material used to prime students. This study suggests that instructor-created videos may be better than 3rd party videos at improving qualitative factors of the classroom environment, especially in the area of math anxiety. As one TF student commented:

When you watch the video outside of class you already know what you're going to be talking about inside of class, so you're like pre-informed of what you need to know. It makes me feel smarter when I come to class.

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