The Effects of the Flipped Model of Instruction on Student Engagement and Performance in the Secondary Mathematics Classroom

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Abstract

In many of the secondary classrooms across the country, students are passively engaged in the mathematics content, and academic performance can be described, at best, as mediocre. This research study sought to bring about improvements in student engagement and performance in the secondary mathematics classroom through the implementation of the flipped model of instruction and compared student interaction in the flipped classroom with a traditional format. The flipped model of instruction is a relatively new teaching strategy attempting to improve student engagement and performance by moving the lecture outside the classroom via technology and moving homework and exercises with concepts inside the classroom via learning activities. Changes in the student participants' perceptions and attitudes were evidenced and evaluated through the completion of a pre- and post-survey, a teacher-created unit test, random interviews, and a focus group session. In addition, the researcher documented observations, experiences, thoughts, and insights regarding the intervention in a journal on a daily basis. Quantitative results and qualitative findings revealed the student participants responded favorably to the flipped model of instruction and experienced an increase in their engagement and communication when compared to the traditional classroom experience. The student participants also recognized improvements in the quality of instruction and use of class of time with the flipped model of instruction. In terms of academic performance, no significant changes

were demonstrated between the flipped model of instruction students and those taught in a traditional classroom environment.

Keywords: Flipped model of instruction; secondary mathematics; active engagement; academic performance

INTRODUCTION

By now it should be beyond dispute the mathematics skills of American students leave a great deal to be desired. Even after a decade of accountability reforms, the performance of U.S. students on mathematics assessments ranges from "simply mediocre to extremely poor, depending on the type of test and grade level" (Schmidt, 2012, p. 133). The National Assessment of Educational Progress (NAEP), the Trends in International Mathematics and Science Study (TIMSS), and the Program for International Student Assessment (PISA) all reveal most students educated in American schools lack the ability to comprehend and apply mathematical concepts (National Center for Education Statistics, 2012). Such weak mathematics performance has rightfully alarmed U.S. policymakers, educators, and the general public.

A report released by the U.S. Department of Education further acknowledged American teenagers are trailing behind their counterparts in other industrialized countries in their academic performance, especially in mathematics (State Educational Technology Directors Association, 2011). Specifically, the report compared U.S. students with students from other countries and identified the U.S. high school students' performance in mathematics to be in the bottom quarter of the countries that participated. Validated by Schmidt (2012), U.S. students' mathematics skills decrease as they develop, "falling from rough parity in the early grades to badly behind their peers by graduation" (p. 136).

According to Weiss and Pasley (2004), a likely cause of the nation's current performance and achievement in mathematics can be attributed to the passive learning experiences students receive in the classroom. Their study found the correlation between students' learning experiences and performance to be rather significant. Based on their observations and interviews of 480 mathematics teachers from 120 high schools across the country, they concluded effective mathematics instruction invited "students to interact purposefully with the content and included various strategies to involve students and build on their previous knowledge" (p. 25). In response to these and other indicators, the National Council of Teachers of Mathematics (NCTM, 2009) encouraged educators to place great emphasis on student-centered learning strategies and students' independent investigations of mathematical ideas in their individual classrooms to improve academic performance.

One such student-centered approach is the flipped classroom model of instruction. The flipped classroom model of instruction is a relatively new teaching strategy attempting to improve student engagement and performance by moving the lecture outside the classroom via technology and moving homework and exercises with concepts inside the classroom via learning activities (Bergmann & Sams, 2012; Brunsell & Horejsi, 2011; Tucker, 2012; Young, 2011). The core idea with this blended learning strategy is to flip the common instructional approach: instruction that used to occur in class is now accessed at home, in advance of class, via teacher-created videos and interactive lessons, and work that used to occur outside of the classroom is now completed in class in the presence of the teacher. Using this inductive approach, Tucker (2012) stated class becomes the place to "work through problems, advance concepts, and engage in collaborative learning" (p. 82). Such use of class time could potentially give students the

opportunity to learn how to think for themselves by being actively engaged in the mathematics content.

This research study sought to bring about improvements in student engagement and performance through the implementation of the flipped model of instruction in the secondary mathematics classroom. Changes in the student participants' perceptions and attitudes were evidenced and evaluated through the completion of a pre- and post-survey, a teacher-created unit test, random interviews, and a focus group session. In addition, the researcher documented observations, experiences, thoughts, and insights regarding the intervention in a journal on a daily basis.

LITERATURE REVIEW

Being a relatively novice approach, research on the flipped model of instruction is extremely limited (Baker, 2000; Davies, Dean, & Ball, 2013; Johnson & Renner, 2012; Lage, Platt, & Treglia, 2000; Strayer, 2007; Talley & Scherer, 2013; Vaughan, 2014). Only one study was located that examined the effects of the flipped model of instruction on student performance and achievement at the secondary level. Specifically, the study inspected the efficacy of the flipped model of instruction in a high school computer application course (Johnson & Renner, 2012). Thus, the need to further investigate this instructional strategy at the secondary level, especially in the content area of mathematics, is critical to deeming this approach as effective and useful.

Baker (2000) had a vision of using electronic means to cover rote material outside of class. He realized during a college lecture that his students were capable of retrieving the notes and slide presentations themselves and encouraged them to do so. In class, rather than lecturing, Baker allowed his students to work together on applications of the principles from the content

under his guidance and direction. Students had a positive perception toward the flipped classroom, indicating learning was more personalized, cooperative learning groups fostered critical thinking, and online resources provided students more control over their learning. Similar to Baker (2000), Lage et al. (2000) flipped their college economics courses and found parallel results. Students thought it was easier to ask questions during class, enjoyed learning from their peers, and found the video lectures online to be quite valuable.

Strayer (2007) reported in most instances where the flipped model of instruction is used, the goal is to create an active learning environment during class meetings while ensuring content coverage. Incidentally, his study's findings, which compared the flipped classroom and the traditional approach in two different college level introductory statistics courses, showed the flipped classroom students were less satisfied with how the structure of the classroom oriented them to the learning tasks in the course. Strayer argued the flipped classroom was "better suited for certain classrooms and courses than others" (p. 198).

Implementing the flipped model of instruction in a high school computer application course, Johnson and Renner (2012) hypothesized students in the flipped classroom would benefit more due to the transitioning of class time from lower-level activities to collaborative group work. However, the students did not fully embrace the flipped classroom expectations. Johnson and Renner assumed the "failed attempt at the flipped model of instruction is what caused such varying results, rather than the intervention itself" (p. 72).

Several studies documented an increase in students' academic performance within the flipped classroom (Davies et al., 2013; Talley & Scherer, 2013). Davies et al. (2013) compared a traditional introductory spreadsheet skills course with a flipped model and found the flipped model of instruction to be more effective. The flipped classroom students demonstrated higher

levels of motivation and improved academic performance when compared to the traditional students. Likewise, Talley and Scherer (2013) flipped an undergraduate psychology course, comparing it to previous semesters of traditional format, and discovered an increase in retention and engagement with the flipped model of instruction. The increase in retention and engagement resulted in improved performance on the midterm and final exams. Davies et al. (2013) and Talley and Scherer (2013) agreed students appreciated the flexibility of accessing course materials, particularly course lectures, on various mobile devices at a time convenient for them.

Most recent, Vaughan (2014) studied preservice teachers' perceptions of the flipped model of instruction as an instructional strategy to reach a classroom full of millennial learners. She argued millennial learners, also known as digital natives, often have access to information at their fingertips and prefer to learn in active and collaborative environments. Specifically, Vaughan (2014) stated the flipped model of instruction provides educators with the means to integrate effective use of technology in their classrooms to promote an active, collaborative environment. Results of her study revealed the flipped classroom improved student engagement, increased student-teacher feedback, and promoted self-paced learning.

While research on the flipped model of instruction is in its early stages, this review of literature indicated the need for further research to better evaluate the instructional strategy's effectiveness in terms of student performance, motivation, and engagement.

METHODOLOGY

Participants

Two Algebra I classes at the research site, a rural 9-12 high school with an average enrollment of 450 students, served as the context for this study. The algebra courses were selected due to the rigorous content and structured curriculum. Both sections were classified as

regular education courses and included a diverse group of students with varying learning abilities. Since these classes employed the flipped model of instruction, the key stakeholders were those ninth grade students enrolled in the courses. The study participants were between 13 and 15 years of age and voluntarily agreed to participate in this research study with parental permission. A total of 42 students (18 boys and 24 girls) participated in the data collection processes of this research study.

Sampling Procedure

In terms of the quantitative aspect of this study, all of the student participants completed the pre- and post-survey as well as the teacher-created unit test for data collection purposes. The sampling procedure used for the qualitative data, including student interviews and a focus group session, was a simple random sampling. An *i*Pad with a name selector app was used to determine the sample. The students' names were entered into the data section of the app, and a random sequence option selected the sample. Twenty-two students were randomly selected to participate in the interviews and focus group session. According to Trochim (2006), simple random sampling is a reasonable method to generalize the results from the sample back to the population. Incidentally, this research study considered simple random sampling as a fair way of selecting the sample from the given population since every member was given an equal opportunity of being selected.

Research Design

This study utilized an action science research design involving the implementation of the flipped model of instruction and the collection and analysis of both quantitative and qualitative data to assess the model's impact on student engagement and performance in the secondary mathematics classroom. Gall, Gall, and Borg (2007) stated action research has played a "growing

role in the field of education in recent years because of its promise for improving educators' practice, strengthening the connection between research and practice, and improving the justice of education's impact on society" (p. 597). The key to action science theory is the implementation of an intervention and an evaluation as to whether or not the intervention improved a situation. For this research study, the intervention was the flipped model of instruction.

Both quantitative and qualitative data were collected and analyzed in this research study. Quantitative data included a pre- and post-survey and a teacher-created unit test; qualitative data included student interviews, a focus group session, and notes documented in the researcher's journal. A mixed methods study provided an opportunity to explore factors that contributed to the impact the flipped model of instruction had on student engagement and performance in the secondary mathematics classroom. According to Creswell (2008), a mixed methods approach is useful when both forms of data can be used to gain a greater understanding of the research problem than either method would by itself. Validated by Suter (2006), mixed methods research in education has "great potential to influence ways of thinking about problems and practices in the teaching and learning process" (p. 65).

Procedure

Permission to conduct the study was obtained and granted by the organization's Institutional Review Board. The flipped classroom model of instruction was implemented over a seven-week grading period to 42 ninth grade students who were enrolled in Algebra I courses at the research site. The students prepared for class by watching videos, listening to podcasts, reading articles, viewing presentations, and contemplating questions on the required topic of study. Completion of homework content notes was used to determine whether or not the students

had adequately prepared for class. During class, the students engaged in hands-on activities, participated in real-world applications, and at times, completed independent practice in the presence of the teacher. Such use of instructional time allowed the teacher an opportunity to assess the students' understanding and comprehension of the content.

For those students with no Internet access at their homes, media was made available on flash drives and DVDs the students checked out and watched at home. In the event a student was still unable to view the content at home, then arrangements were made for that student to view the media pieces during Response to Intervention (RtI) time so he or she could be adequately prepared for class.

Prior to the flipped model of instruction intervention, the student participants completed a confidential pre-survey assessing their learning experiences in a traditional classroom setting. The flipped content focused on solving and graphing systems of equations and systems of inequalities. Throughout the flipped model of instruction intervention, observations, experiences, thoughts, and insights were documented in a journal on a daily basis. The journal also served as a means of brainstorming to expand upon impressions and thoughts about what was occurring throughout the study. After experiencing the flipped model of instruction for seven weeks, the student participants completed a confidential post-survey assessing the model's impact on their learning experiences. Responses for each Likert scale rating for each statement on the pre- and post-surveys were analyzed by calculating the mode. According to Ary, Jacob, and Sorensen (2010), Likert-type items classified as ordinal measurements are best described using the mode when analyzing such data. In addition, in order to gain a deeper understanding of the survey results, the percentages of students choosing *strongly agree* and *agree* for each statement on the pre- and post-survey were calculated.

At the conclusion of the flipped model of instruction intervention, the student participants also completed a teacher-created unit test covering the flipped content. This assessment was used in years past and mirrored the Algebra I End-of-Course questions on solving and graphing systems of equations and systems of inequalities. The teacher-created unit test was graded based on the district grading scale. Measures of central tendency and variance, including the mean, median, mode, and range, were calculated to better describe the unit test data. In addition, with the use of an online electronic gradebook, the same assessment given to similar Algebra I sections taught in a traditional approach were accessed and compared to the test data gathered from the flipped model of instruction delivery format. An independent-samples t-test was performed in Microsoft Excel to determine if there was a significant difference in performance between the two groups of students.

After the seven-week period, students were selected using a simple random sampling technique to participate in interviews to gain a deeper understanding of their unique experiences related to the flipped model of instruction. A total of 12 interviews were completed. For the focus group session, ten students were selected via a simple random sampling technique to discuss their perceptions of the flipped model of instruction and its impact on their engagement and performance. Qualitative data analysis was conducted on the student interviews, the focus group session, and the researcher's journal. Specifically, a thematic analysis of the qualitative data was completed and involved searching for themes within the data through a repeated process of capturing keywords, journaling in logs, and coding responses from interviews and observations. Beginning on the first day of the flipped classroom intervention, the process of looking for recurring themes began. As the observations continued and the interviews started, a constant state of comparison from one day to the next and one interview to the next transpired in

order to expand, contract, delete, or add codes and categories. The qualitative data was analyzed and revisited until the point of saturation was reached. Creswell (2008) noted, "Saturation is the point where you have identified the major themes and no new information can add to your list of themes or to the detail for existing themes" (p. 257).

Instrumentation

The survey instrument, Student Perception of Instruction Questionnaire (SPIQ), was previously used in a study comparing blended and face-to-face course delivery options (Araño-Ocuaman, 2010). In her particular study, Araño-Ocuaman used the instrument to measure areas where technology impacted or improved student learning and engagement. Permission to use the instrument with modifications to fit the needs of this research study was obtained through the doctoral committee chair due to the recent death of the author. As described by Araño-Ocuaman, Cronbach's alpha was used to measure the reliability of the instrument. Of the possible 36 students in her study, twenty-seven valid responses to the questionnaire were used to arrive at the Cronbach alpha coefficient of α=0.731. As noted by Araño-Ocuaman, a reliability coefficient of 0.70 or higher indicated an acceptable level of reliability in most educational research.

Field Test

A field test was conducted prior to the implementation of the flipped model of instruction assessing the appropriateness of the interview and focus group session questions. Ten educational leadership experts were contacted via email and asked to review the interview and focus group session questions for credibility. Specifically, the experts were asked to determine whether or not the questions asked were clear, appropriately worded, open-ended, and in alignment with the overall research questions proposed in the study. Feedback encouraged simplifying the wording in some of the interview questions so the study participants would not

have to endure any distress or discomfort. In addition, the district's Assessment, Research, Special Services, and Accountability department reviewed the instruments and stated all were aligned with the study's intended purpose.

RESULTS AND FINDINGS

Quantitative Results

Many of the student participants selected *strongly agree* or *agree* for the statements on both the pre- and post-survey. For many of the statements, this was indicative of a satisfactory student perception with both the traditional and flipped classrooms, thus revealing minimal variations between the two delivery approaches. One important inference recognized for many of the survey statements included a change in the most common response from *agree* with the traditional classroom to *strongly agree* for the flipped classroom. Some of the survey statements included: I actively participated in all aspects of the course; my desire to learn improved as a result of this course; and I worked hard to learn the content.

The difference among performance measures between the traditional and flipped classrooms can be described as insignificant. An independent-samples t-test was conducted on the teacher-created unit test to compare performance between students in the flipped model of instruction classroom and those in the traditional classroom environment. There was not a significant difference in performance between those students taught using the flipped model of instruction ($M = 80.38$, $SD = 11.02$) and those who were in the traditional classroom environment ($M = 80$, $SD = 11.56$); $t(80) = 0.15$, $p = 0.44$. These results suggested similar performance abilities between the traditional and flipped classrooms on the content covered on the unit test.

Qualitative Findings

The following keywords and phrases were found to be repetitive in the interview and focus group transcriptions: actively engaged in learning; attentive; better use of class time; class different from others; exciting; flip easier content; hands-on learning; helpful; independent learning; individualized learning; innovative teaching; interaction; more communication with peers and teacher; more participation; one-on-one instruction; real life examples and projects; refreshing; and technology. Comparing these keywords and phrases to the researcher's journal, the following emerging themes were identified: active engagement and learning; class time and structure; quality of instruction; collaboration; and communication.

Active engagement and learning. Several of the student participants commented how the flipped model of instruction encouraged active engagement and increased their participation in the Algebra I classrooms. In fact, all of the participants in the focus group session mentioned how they experienced an increase in classroom participation when compared to class time prior to the flipped model of instruction intervention. In particular, the student participants acknowledged their passive interactions during class lectures and limited communication between their teacher and other peers prior to the flipped model of instruction intervention. Conversely, during the flipped classroom, the students witnessed an increase in their classroom participation and communication, thus promoting a student-centered classroom environment conducive to learning and success.

Furthermore, the researcher's journal documented a large amount of days in which the students were actively participating in the classroom activities and enthusiastically involved in all aspects of the classroom happenings. As described in the researcher's journal, a typical day in the Algebra I flipped classroom warranted three groups of students: one group of students

entered class and immediately began working on their independent practice problems without the teacher's assistance; a second group of students gathered around the Promethean Activboard and reviewed the content with the teacher; and a final group congregated at the back of the room and viewed the media pieces collaboratively on the classroom computers and their personal electronic devices. The student participants joined one of the three groups on their own initiative based on their current level of understanding and rotated among the groups as needed until they were confident in their abilities to solve the problems independently.

Class time and structure. Another theme derived from this study involved the unique class time and structure which resulted from the intervention. When compared to the traditional environment, the student participants argued there was better use of class time with the flipped model of instruction. Specifically, the students shared stories of how there were times when they did not feel like taking notes and listening to a lecture on new content. Some students commented how they were pretending to be involved during the lectures, but were really daydreaming about after school football practice. Others stated having algebra class first hour and having to listen to the teacher lecture that early in the day were not effective combinations. With the flipped model of instruction, the students had the luxury of being introduced to new content prior to class and were able to review the media pieces over and over until they fully understood the content being demonstrated. The focus group session revealed many of the students felt the greatest advantage to the flipped classroom was having the ability to replay the videos when they did not have a complete, thorough understanding of the problem solving process. This was certainly an advantage the students did not experience in the traditional classroom environment.

Quality of instruction. When compared to the traditional approach to teaching, the student interviews revealed improvements in the quality of instruction within the flipped classroom. Specifically, the students discussed their preference of the flipped model of instruction over the traditional approach and credited this liking to improved instructional practices. Many of the student participants did not feel direct instruction with lectures and note taking requirements was an effective method of teaching. Instead, the students thought the flipped model of instruction was more effective and applicable because of the variety of teaching practices incorporated within this approach. Some of the practices discussed included: group work, hands-on activities, discovery learning, project-based learning, and real world applications. Students shared how they previously thought effective teaching only involved listening to lectures and taking notes; however, after experiencing the flipped classroom, they gained a new understanding of what effective teaching looked like. Ultimately, the students preferred a classroom environment where a variety of instructional practices were utilized rather than one that only used direct instruction with lectures and note-taking requirements.

All of the students felt the use of technology and one-on-one teaching in the flipped model of instruction enhanced the quality of instruction. The interview participants shared story after story of how the use of technology promoted an increase in their level of engagement. One student verbalized his preference of using technology which caused an increase in his motivation to learn and succeed; another stated many of her classes did not use technology so her experience in the flipped classroom was viewed as engaging and pleasing. The students enjoyed viewing the teacher-created media pieces at a time convenient for them and felt having access to the videos 24 hours a day was quite advantageous. Students mentioned how valuable it was to review the media pieces prior to classroom assessments, a bonus not experienced in the traditional

classroom environment. In addition, the focus group session demonstrated the students' satisfaction of having more one-on-one time with the teacher during the flipped model of instruction intervention. Specifically, the students discussed how additional private time with the teacher confirmed their understanding or need to further study the content. Many times, in the traditional classroom, the students' individual needs and confusion would go unnoticed. In the flipped classroom, the teacher was able to speak with every student in every class and address unique concerns or questions about the current topic being studied.

While the qualitative data showed the flipped model of instruction improved the quality of instruction, the student participants also acknowledged the challenges in flipping difficult content. The student interview participants recognized solving and graphing systems of equations and systems of inequalities via the flipped model of instruction were quite difficult and demanding. Not only was a new approach to learning introduced to the students, but content requiring extremely high levels of higher order thinking was also presented to them. The students noted their preference of the flipped model of instruction; yet, they felt the instructional approach should have been introduced to them during easier content in order to promote and facilitate a classroom environment more conducive to learning and success.

Collaboration. Collaboration emerged as a major theme while assessing the flipped model of instruction's impact on student engagement and performance in the secondary mathematics classroom. The student interview participants commented on the model's increased use of group work and how it functioned to improve their participation and involvement in the classroom. One student remarked how the shared support and collaboration by other peers in the classroom helped him build his confidence and improve his understanding of the mathematics content. Additionally, he mentioned the importance of working collaboratively in completing the

tasks associated with the hands-on and project-based learning activities. Other students shared their enthusiasm to finding success in the flipped classroom and credited that success by having the opportunity to work with and learn from their peers on a daily basis. They stressed the idea of having solid teamwork skills helped them find success in other core classes and even in some of their extracurricular activities.

In addition, the student participants in the focus group session viewed group work assignments as far more effective than listening to a lecture and taking notes. The students felt there would always be a time and a place for direct instruction, especially in mathematics; however, they agreed collaborative tasks required each of them to take an active role in the learning process. The researcher's journal validated this theme in the daily observance of the variety of groups of students working together to learn and master the content being studied. Distinctly, the flipped model of instruction provided the students with opportunities to work collaboratively and cooperatively in order to improve engagement and performance in the secondary mathematics classroom.

Communication. A final theme demonstrated throughout the qualitative data included the importance of student-to-student and student-to-teacher communication. The focus group session demonstrated students felt communication was improved in the flipped classroom. Compared to the traditional environment, the student participants agreed there were more interactions between their peers and the teacher in the flipped classroom. The students verbalized their satisfaction of working with their peers in the flipped classroom by discussing problems, sharing solutions, and validating their thought processes. In addition, all of the student interview participants said they had the opportunity to talk with the teacher each and every class period during the flipped model of instruction intervention. The students viewed this increase in

communication as an important contribution to their positive experience with the flipped classroom.

Discussion

Regarding the area of student engagement, the results and findings of this research study indicated students were more engaged, more involved in the flipped model of instruction when compared to the traditional delivery approach. Eighty-eight percent of the students surveyed stated they actively participated in all aspects of the flipped classroom compared to 76% in the traditional classroom environment. One of the interview questions asked the students to describe their role in the flipped classroom. Interestingly, all of the student interview participants used the word *active* to answer this question. Some of their descriptions included: actively helping, actively learning, actively listening, actively participating, and actively working. Moreover, the student participants openly acknowledged their passive interactions during class lectures and limited communication between their teacher and other peers prior to the flipped classroom intervention. During the flipped model of instruction, however, the students witnessed an increase in their classroom participation and communication. Thus, the flipped model of instruction had a positive impact on student engagement.

With respect to the area of student performance, the results of the teacher-created unit test demonstrated similar performance abilities between the traditional and flipped classrooms. Specifically, the mean (average) for the traditional classroom was 80 out of a possible 100; the mean for the flipped model of instruction classroom was 80.38 out of a possible 100. An independent-samples t-test analysis confirmed the conclusion that no significant difference in performance existed between those students who were taught traditionally and those in the flipped model of instruction classroom. While the performance abilities appear similar, it was

important to note the students verbalized their concerns over the flipped content covered on the teacher-created unit test. Many of the student participants recognized the difficulty in solving and graphing systems of equations and systems of inequalities. Such content required high levels of higher order thinking skills, and many of the students felt this content was the most difficult of everything learned during the school year. Not only was a new approach to learning introduced to the students, but extremely challenging content was also presented to them. While the students noted their preference for the flipped model of instruction, they felt the instructional approach should have introduced to them during easier content in order to lessen the demands and challenges of having to learn both a new approach and extremely difficult content. Unquestionably, the impact of the flipped model of instruction on student performance demonstrated similar results when compared to the traditional approach.

Comparing student interactions in the flipped model of instruction to the traditional environment revealed significant information. The students were more actively involved in the flipped classroom than the traditional environment. The researcher's journal documented a student-centered environment within the flipped classroom. The students worked collaboratively among the various groups as they learned from each other by discussing problems, explaining procedures, and confirming answers. The teacher functioned as a facilitator, only guiding and directing when needed. On days when hands-on activities were utilized, the students demonstrated levels of eagerness and excitement not before observed in the traditional classroom environment. One activity required the students to compare the speed at which they wrote with their left hands to the speed of their right hands. This hands-on activity allowed the students the opportunity to develop a conceptual understanding of the three different types of solutions associated with solving systems of equations. Not only were the students able to demonstrate and

visualize the three types of solutions, they were also able to interpret and share what those solutions represented in terms of the speed of their left and right hands. In addition, the students were eager to compare their results to others in the classrooms. Such actions allowed the students a solid understanding of explaining and interpreting solutions to systems of equations when other scenarios and problems were presented to them.

Interestingly, the student participants responded favorably to the flipped model of instruction; however, their academic performance did not show any significant changes when compared to students taught under the traditional approach. This finding suggested the student participants responded to and enjoyed variety in their Algebra I classrooms. While the flipped model of instruction offered a sound way to modifying classroom instruction, this study did not reveal any significant changes among the students' academic performance when compared to students within the traditional classroom. Thus, depending on the content, the traditional approach may be the most efficient method of instruction; yet, the flipped model of instruction may be the best approach for other content. As evident in this research study, the use of various instructional approaches in the secondary mathematics classroom has the potential to yield a positive impact on student engagement and performance.

Limitations

After reviewing the results of this research study, the following limitations were recognized:

1. The researcher acknowledged the limited time frame of the project. Even though the student participants responded favorably to the flipped model of instruction during the seven weeks of implementation, there is a need to confirm these findings with a longer, more extensive research study. By conducting such a study, more

comprehensive quantitative data and more descriptive qualitative data can be collected and analyzed to gain a deeper understanding as to how the flipped model of instruction affects student engagement and performance.

2. One of the emerging themes observed with the flipped model of instruction was the quality of instruction. Specifically, the students mentioned how the use of technology helped to improve their engagement and performance in the flipped classroom. According to Kuykendall, Janvier, Kempton, and Brown (2010), the novelty effect is the tendency for performance to initially improve when technology is instituted. If the novelty effect was indeed a factor in this research study, future research must be designed to determine at what point the technology loses its effect and improvement is based solely on the flipped model instructional strategy. In connection with the previous limitation, a more extensive study with a longer time frame would provide this valuable information.
3. The analysis of student performance was limited in this research study as well. The student participants verbalized their concerns of having to learn both a new instructional approach and challenging content requiring high levels of higher order thinking skills. Many of the students suggested the flipped classroom should have been introduced to them during easier content, allowing them more time to focus on the content and less time on the routines and procedures of the new classroom environment.
4. A final limitation of this research study involved the implementation of the flipped model of instruction in only one teacher's classroom. The one classroom teacher was also the researcher of this study and the one who taught the student participants in the

traditional classroom environment. In particular, the researcher's goal was to effectively teach the subject matter at hand regardless of the approach. Thus, the design of the traditional classroom environment may have been just as effective as the design of the flipped classroom environment given the common subject matter taught in this study. By conducting a more extensive study involving more classroom teachers, the findings and results of this study can be further investigated.

CONCLUSION

Results and findings indicated students were more engaged, more involved in the flipped model of instruction when compared to the traditional delivery approach. Students in the flipped classroom experienced quality instruction that was student-centered and student-focused. The flipped classroom allowed for improved use of class time utilizing various instructional strategies, including hands-on activities and project-based learning structures. While research on the effectiveness of the flipped model of instruction is limited, this research study provided additional, valuable information regarding the model's impact on student engagement and performance. Even though the flipped model of instruction is a relatively new instructional approach, it certainly has the potential to be deemed effective in terms of improving student engagement and performance in the secondary mathematics classroom.

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