Spring 2019

Beneficial or Not: Flipped Learning in an Elementary Mathematics Classroom

Nicole Jackson
California State University, Monterey Bay

Beneficial or Not: Flipped Learning in an Elementary Mathematics Classroom

Nicole Jackson

Thesis Submitted in Partial Fulfillment of the Requirements for the
Degree of Master of Arts in Education

California State University, Monterey Bay
May 2019

Beneficial or Not: Flipped Learning in an Elementary Mathematics Classroom

Nicole Jackson

APPROVED BY THE GRADUATE ADVISORY COMMITTEE

Kerrie Chitwood, Ph.D.
Advisor and Program Coordinator, Master of Arts in Education

Dennis Kombe, Ph.D.
Advisor, Master of Arts in Education

Approved by the Dean of Graduate Studies 05/21/2019

Kris Roney, Ph.D. Associate Vice President
Academic Programs and Dean of Undergraduate & Graduate Studies

Abstract

The Flipped Classroom is becoming a more frequently used instructional strategy in many secondary and collegiate classrooms. However, there are few studies done in elementary classroom settings that have implemented the flipped classroom approach to instruction. Research suggests that flipped classes have a positive impact on student learning and assessment outcomes. This study examined the impact of flipped classroom on second grade students' mathematics achievement. The study used a two group, quasi-experimental, pre-test/ post-test design. 46 second grade students in two classes of 23; one control- traditional instruction and one experimental- flipped classroom instruction, were engaged in a four-week intervention. They were assessed on a Eureka Math End-of-Module assessment for both pretest and posttest. Results indicated no statistically significant differences between groups for both pretest and posttest, but there were statistically significant differences for each group from pretest to posttest. The control group started and ended higher than the experimental group, but the experimental group had a greater gain in learning based on their pretest and posttest assessments. The results reinforce the discussion that flipped classroom instruction can improve student learning for elementary and second grade students.

Keywords: Flipped classroom; elementary; mathematics; second grade

Acknowledgements

Thank you to friends and family who have supported me through the process of reaching my goals. Thank you to my coworkers and friends who helped with editing, revisions, and being an inter-rater observer. A final special thank you to my professors who encouraged and helped me work to by best potential.

Table of Contents

Beneficial or Not: Flipped Learning in an Elementary Mathematics Classroom

Literature Review

To keep up with technology and how students learn with the changing times, it is important to use the tools available to best meet students' needs. One tool is the flipped classroom (Araujo, Otten, & Birisci, 2017; Freeman, 2012; Lai & Hwang, 2016; Tucker, 2012). The flipped classroom is a newer method of teaching that has demonstrated increases in academic performance and improvements in assessment outcomes (Low, Hew, & Chen, 2017). This strategy reverses the traditional instructional approach. Teacher-created videos are assigned for homework prior to class. The following day the traditional homework practice is done in class. This type of classwork allows students to work through problems, solve complex concepts, and engage in collaborative learning with the teacher and peers in one-on-one and small group formats (Tucker, 2012). Furthermore, the flipped classroom provides the students and teacher more time to apply and practice newly learned concepts in class. This additional time allows the teacher to effectively teach, reteach, and cover additional topics. Additionally, the teacher has more time to assist struggling students (Bhagat, Chang, & Chang, 2016). The use of technology in the flipped classroom makes providing instruction and gaining access to content much easier and more readily available (Freeman, 2012). Finding what works best for students is a priority and the flipped classroom lends itself well to reaching those goals (i.e., increasing deeper concept knowledge, easier access to academic material at home, and improved assessment results).

Flipped classrooms are the opposite of the traditional instructional approaches to classroom instruction. In traditional classrooms, often the teacher is the main focus and students usually memorize and repeat information. The students then may play a game on technology tools or practice a program with little stimulating engagement. Consequently, this creates students that display a lack of drive for development of motivation and self-regulated learning (Lai & Hwang, 2016). This type of instructional approach may not identify students who continue to struggle with acquiring content knowledge (Freeman, 2012). Furthermore, when the single modality presentation style is used, it only allows students to use one cognitive channel: visual or audio/ listening or reading. Solely relying on one modality can be cognitively demanding for students and can cause cognitive overload, a situation in which information is not stored correctly or at all because of exceeded mental limits in information processing (Mattis, 2015). However, the flipped classroom allows students to take charge of their education and to acquire self-regulation skills to monitor their learning and needs with assistance from the teacher (Lai & Hwang, 2016). This learning strategy can increase students' motivation and reflection on their own learning. This is important because students can go deeper and comprehend more complex ideas (Lai & Hwang, 2016). In addition, there is an increase in engagement as students enjoy the learning process more when given the opportunity to self-regulate their learning.

Kim, Park, Jang, and Nam (2017) conducted a study at a Korean university where they used Korean as the foreign language to learn academic material. They explored the effects of the flipped classroom on the cognitive processing of second language learners. The researchers found that students had more active involvement and enjoyment of the learning process. Related studies have shown that with the flipped classroom, students can address what they enjoy, their learning needs, and ask for help; and that students feel more comfortable with individualized and small group attention (Araujo et al., 2017; Lai & Hwang, 2016). Therefore, students take control and become responsible for their learning pace and process. Furthermore, some students may take on the role of the teacher for their peers, so those needing additional help do not have to wait for the teacher's assistance (Araujo et al., 2017). Consequently, teachers have more time to provide meaningful activities that engage students in higher order thinking (Lai & Hwang, 2016). The effectiveness of the flipped classroom could successfully serve as guidance to support and bridge the students' learning both inside and outside of the classroom. Students are capable of reviewing, constructing, and practicing their learned knowledge (Hwang & Lai, 2017). In addition to the aforementioned advantages of the flipped classroom, there are four important benefits that should be considered.

Benefits of flipped classrooms

The flipped classroom is an innovative approach to teaching students at all levels including primary, secondary, and collegiate levels (Bhagat et al., 2016; Mattis, 2015). Research on the use of flipped classroom in secondary education describes benefits in increasing academic scores in various subjects such as history/social studies, science, and mathematics (Bhagat et al., 2016). Furthermore, students in a college algebra course and a computer programing course reported that the use of a flipped classroom provided a deeper understanding of material. The students then produced significantly improved assessment scores (Kim et al., 2017). Although these are promising findings for secondary students; there are few studies that explore the use of flipped classroom as an approach to increase student achievement for elementary grades (e.g., Lia & Hwang, 2016; Tsai, Shen, & Lu, 2015). Therefore, it is uncertain as to whether the flipped classroom approach would be an effective strategy to increase academic scores for students in the lower grades. In addition to the improved assessment scores, the use of a flipped classroom may improve student motivation.

Motivation. Motivation is defined as the development and sustaining of an internal drive to reach a goal (Schunk, 2016). This is a valuable aspect of the flipped classroom. The flipped classroom may increase students' competence and autonomy, which would then result in greater levels of both intrinsic and extrinsic motivation (Bhagat et al., 2016). An increased motivation to learn and stronger development of self-regulation can improve academics such as mathematics (Lai & Hwang, 2016). As students take more control of their learning they can become more self-regulated. Self-regulated learning is a process that enhances student motivation to learn and reflect on the learning process. Ultimately, this self-reflection contributes to increased success in learning (Lai & Hwang, 2016). Students who are active participants in the learning process experience a positive impact on cognitive and language skills. This increases overall achievement. Consequently, when students are motivated they increase their cognitive capacity to learn (Kim et al., 2017).

Reaching All Learners. When considering how students learn, it is important to look at who they are and their needs. Looking at all levels: above grade level, at grade level, below grade students, as well as English Language Learners (ELLs), the cognitive aspect plays a critical role in students' achievement (Freeman, 2012; Kim et al., 2017). According to Freeman (2016), it can take ELL students four to seven years to achieve academic language proficiency when compared to their English only peers. Students processing information in their second language consume more cognitive capacity than in their first language which leaves little room for higher-order thinking (Kim et al., 2017). Thus, flipped classroom can affect how well second language learners process, understand, and organize their thoughts and learned information in the second language (Kim et al., 2017). Additionally, students being able to receive the content knowledge outside of class and at their own pace through multiple modalities (i.e., auditory, visual, kinesthetic, and tactile) frees up more cognitive capacity and creates opportunities for them to engage in more complex activities during class (Kim et al., 2017; Mattis, 2015).

Furthermore, it is important to consider how socioeconomic differences impact students' learning. If students do not start school with equal means to achieve they may not have equivalent capabilities. Often the blame of students not performing well is placed on students that are not placed effectively. Consequently, "expecting equal success from unequal beginnings" (Freeman, 2012) hinders student learning. It can potentially limit what students can or cannot do in the future. This is a part of what shapes how the students learn, what they perceive, and how they understand the world around them (Freeman, 2012). Socioeconomic realities affect students' language, math skills, and confidence. Flipped classroom can meet these students where they are at their current learning capabilities by allowing students to gain content, expand on learned information, and increase their cognitive processing and language skills; especially within the field of mathematics.

Mathematics. Mathematics involves a great deal of academic vocabulary that can be addressed through flipped classroom (Freeman, 2012). That is, the videos the students view at home provide academic vocabulary and concepts that can be reviewed, listened to, and rehearsed repeatedly. This is especially crucial in the field of mathematics because students need to build foundational concept knowledge and skills in the early grades. Without the foundational knowledge, students will fall behind as the content builds and spirals consecutively through the years (Freeman, 2012). According to Araujo and colleagues (2017), students who participated in a flipped classroom expressed feeling more engaged. Students attributed the engagement to additional time allowed for collaboration, working on problems, and learning from their peers. Therefore, the implementation of a flipped classroom supports the notion that both students and teachers gain multiple benefits from collaborative learning and peer-centered support (Araujo et al., 2017). In summation, flipped classrooms offer benefits which include students' and teachers' having a positive outlook; an increase in interaction within the learning environment; more active engagement during class; and increased language use with peers. These circumstances can produce greater achievement on formative and summative assessments (Kim et al., 2017).

Challenges with Implementing Flipped Classroom

Though there are significant positive impacts of the flipped classroom, there are also challenges. In review of the research there were three common sections of challenges that emerged: teachers, students, and operational challenges (Low & Hew, 2017). The most prominent concern was with the students' challenges with flipped classroom. The pre-class workload required to watch videos and not having opportunities to ask questions directly and immediately to the teacher when working through the lesson was difficult for students. (Low et al., 2017). Additionally, sometimes students did not have devices or access to internet to watch the videos; and mostly did not have technological help with problems that arose (Low & Hew, 2017). Finally, students' lack of familiarity with flipped classrooms, and challenges with content made flipped classrooms appear ineffective (Low & Hew, 2017; Low et al., 2017). Consequently, not every student responded favorably to the change in instruction (Akcayir & Akcayir, 2018; Low et al., 2017).

Another concern was from the teachers who noted challenges related to a lack of knowledge in implementing flipped classrooms as well as the extra time required to create videos (Low et al., 2017). Additional technological challenges for teachers included making their own videos which could become a daunting task depending on their technological skills and institutional supports (Akcayir & Akcayir, 2018; Low & Hew, 2017). Finding high quality, content appropriate, and length appropriate videos by teachers not creating their own hindered in successfully implementing flipped classroom (Akcayir & Akcayir, 2018). If not done well, the challenges may diminish the advantages of the flipped classroom (Akcayir & Akcayir, 2018). As with trouble shooting the technology, the availability of programs or apps to track whether or not students had truly watched the videos was an additional concern. Teachers noted that much like the traditional homework, students who did not watch the videos subsequently struggled in class. Students not watching the videos could potentially cause the implementation of flipped classroom to fail (Araujo et al., 2017). Subsequently, some teachers mentioned feeling more removed from their students and not having as much of a personal connection they had with traditional instruction (Araujo et al., 2017). Many of the challenges mentioned were found in both K-12 and secondary school classes (Low & Hew, 2017).

Methods

There are few studies that have investigated differences in students' engagement and learning processes in flipped versus traditional mathematics at the elementary classroom setting (Low & Hew, 2017). For example, a recent review of literature found that of 15 studies on flipped classrooms conducted in K-12 settings, 13 were at the secondary school level, while the two remaining studies were in upper elementary schools (Low & Hew, 2017). There is still little research on the use of flipped learning in lower elementary classrooms, specifically with second grade Mathematics. The purpose of this study was to look at the effectiveness of flipped classroom instruction (Araujo et al., 2017; Freeman, 2012; Lai & Hwang, 2016; Tucker, 2012) in mathematics with second grade students to determine if there were differences in math benchmark scores for students in a flipped classroom compared to students in the traditional style instruction.

Research Question

Does the flipped classroom instructional style improve benchmark math test scores for second grade students?

Hypothesis

Based on a review of research (Araujo et al., 2017; Freeman, 2012; Lai & Hwang, 2016; Tucker, 2012), my hypothesis is that second grade students receiving flipped classroom instruction will have greater improvement in their mathematics benchmark tests when compared to peers receiving traditional classroom instruction.

Research Design

The research used a quantitative quasi-experimental nonequivalent groups pretest-posttest design. Two groups of second grade students were selected. One group was experimental and the other was used for control. Both groups of students received a pretest and a posttest on Eureka Math module 6. The module included questions on the foundations of multiplication such as identifying arrays, splitting arrays, and recognizing equal groups in preparation for learning how to multiply. The experimental group received a four-week intervention.

Independent variable. The independent variable in this study was the instructional strategy of the flipped classroom. The flipped classroom instructional strategy happens when the teacher gives students content instruction in the form of a video to be viewed for homework the night before, and then subsequently, students practice the math concepts in class. Students and teacher think of and use homework in a different way, as more in-class practice. Instruction is now expected to be learned at home and to be ready to perform the learned content in class. Thus, switching what was homework now for classwork and what was in-class lecture now for homework in video form (Araujo et al., 2017; Freeman, 2012; Lai & Hwang, 2016; Tucker, 2012).

Dependent variable. The dependent variable in this study was the students' achievement in mathematics as measured by Eureka Math CCSS-aligned test through Edulastic (Edulastic, 2018; Eureka Math/Great Minds, 2018). Mathematics is defined as the relationship and science of numbers expressed symbolically in operations and procedures (Mathematics, 2018). Achievement is defined as a student's effort in quality and quantity in work that leads to their results (Achievement, 2018). The test was created by choosing Eureka Math assessment through the Edulastic testing platform that aligns with the standards students were learning during the study. See Appendix A. The standards that were measured on the Eureka Math test were from module 6: foundations of multiplication and division.

Setting & Participants

The study took place in two second grade classrooms consisting of 46 students, 23 in each class, at a public elementary Title 1 school. The school is immersed in a diverse agricultural community within a town of approximately 150,000 in Central California. The school has an enrollment of 544 students. 268 of them are females and 276 are males. The school consists of 236 English language learners (43%) with 99.6% report Spanish as their primary language. Furthermore, 83% of students qualify for free and reduced-price meals (Ed-Data, 2018). The classes chosen for this study are representative of the larger population of students in the school. Moreover, they were the population that was readily available and accessible to use (i.e., convenience). However, the two groups were chosen based on similar demographics (i.e., purposeful).

The school district provides one-to-one technology for students. Each student is given an 11-inch touch screen Chromebook in grades K-2 and 14 inch Chromebooks in grades 3-8. The study used non-random, purposeful convenience sampling with two classes taught by different teachers. One taught the experimental group and the other taught the control group. The researcher was the teacher implementing the intervention and the other teacher was teaching the control group. The instructor of the control group was selected based on similarities of students within the two classes. Additionally, the colleague was teaching with Eureka Math and not using videos or Google Classroom. The colleague was informed of the research goals through discussion of expectations about teaching the math program as designed without flipped classroom instructional strategies prior to the implementation of the research. The fidelity checklist was also reviewed.

Experimental group. The experimental group of 23 students was taught by the researcher. The group contained 11 females and 12 males. Of these students, 10 were Spanish speaking ELLs with seven being reclassified for RFEP as English proficient this school year. In regard to academic standing, there were 4 students performing far below grade level standards (low), 8 students performing just below grade level standards (medium), and 11 students performing at and above grade level standards (high). Their ethnic diversity consisted of 4 Caucasian students and 19 Hispanic students. The socio-economic status of the students consisted of 6 low-income and 17 middle-income families. All 23 students participated in the intervention of flipped classroom instructional strategy in mathematics. All students received the video of the content lesson through Google Classroom that was completed as their homework. In class, students participated in guided math practice, project-based lessons, and independent work. Small groups and one-to-one support was used to assist with the lesson content that was provided in the videos.

Control group. The control group of 23 students was taught by a grade level colleague of the researcher. The group contained 12 females and 11 males. Of these students, 10 were ELLs with 9 Spanish speaking students and 1 Mandarin Chinese speaking student. Furthermore, seven of the students were reclassified for RFEP as English proficient this school year. In regard to academic standing, there were 3 students performing far below grade level standards (low), 8 students performing just below grade level standards (medium), and 12 students performing at and above grade level standards (high). Ethnic diversity consisted of 3 Caucasian students, 19 Hispanic students, and 1 Asian student. The socio-economic status of the students consisted of 7 low-income and 16 middle-income families. All 23 students participated in the traditional teaching method with the curriculum. In the traditional model, students participated in in-class lectures of the same mathematics standards. For the homework portion, students were assigned homework pages that aligned with the lessons from the Eureka Math curriculum (Eureka Math/Great Minds, 2018). A fidelity checklist (see Appendix B) was used with the independent observer to confirm the colleague used the Eureka Math curriculum as assigned and designed.

Measures

This study used a digital assessment platform through Edulastic.com for the CCSS-aligned Eureka Math assessments to measure students' progress. A pretest and posttest was utilized to measure the effectiveness of the flipped classroom instructional strategy (Edulastic, 2018; Eureka Math/Great Minds, 2018). See Appendix A. Questions were designed so that students moved items around or typed in to answer. For example, some questions required the student to drag and drop numbers. Others required them to solve word problems. Further questions had students chose the correct or incorrect pictures of arrays. The test included 8 questions and took about 30 minutes for all students to complete. The assessment was scored immediately through the digital testing platform Edulastic. Both the control group and experimental group took the same pretest and posttest through Edulastic. Posttest questions were the same, but reorganized in a different order to ensure the students did not memorize answers.

Validity. The pretest and posttest were developed by Edulastic based on Eureka Math curriculum that is aligned to Common Core State Standards (Eureka Math/Great Minds, 2018; Edulastic, 2018). Edulastic is an online program that has a multitude of expert-created standard-aligned assessments that are built off previously validated measures. Thus, the Edulastic assessment has construct validity and can be used in this study (Edulastic, 2018).

Reliability. There were multiple factors that made this measure reliable. One is using Edulastic, as it has an answer key and scores automatically. Furthermore, the researcher could not change the score (Edulastic, 2018). Students and teacher were given the scores immediately after the assessment was complete. Also, the teacher was unable to go back in and change their scores in the program. Students were given a pretest and posttest called the End-of-Module assessment in the Eureka Math curriculum (Eureka Math/Great Minds, 2018). These factors, along with using the assessment and same testing platform consistently and over time, made the scoring and data that was produced reliable.

Intervention

The intervention used in this study was the flipped classroom instruction model (Araujo et al., 2017; Freeman, 2012; Lai & Hwang, 2016; Tucker, 2012). This intervention was used to increase students' mathematics knowledge, achievement, and retention. Instruction of the main concept of the lesson was delivered through a video the teacher had created, which was most frequently used. A video created by someone else on Youtube (Youtube, 2019; e.g., Eureka Math Grade 2 Module 6 Lesson 3 by Duane Habecker; Concept of Multiplication For Kids | Grade 1 Maths For Kids | Periwinkle; What is Multiplication? | Multiplication Concepts for Kids by Rock 'N Learn) was used when they presented the material in a stronger more relatable way to the students. The videos were posted on average of three times a week with a goal of four for Monday night through Thursday night. The videos were posted on Google Classroom through Edpuzzle (Edpuzzle, 2019) for homework for the students to watch the night before instruction/practice on the concept. Edpuzzle was used to track student usage such as, video percentage watched and day/time the video was watched. Students watched a video that was generally around ten minutes long and clicked the "mark as done" button when viewing was complete. Students had the opportunity to watch the video multiple times, pause the video, and access it at other times to review the material in the lesson. If students that unable to watch the video at home, they were given the opportunity to watch it in class on their Chromebook before practice of the new concept began.

The following day students practiced the new concept with the problem and homework set worksheets in the Eureka Math curriculum consumable books. The worksheets increased in complexity to reach all levels of learners. They also participated in a few creative project-based and kinesthetic activities (i.e., acting out math problems, using large shapes to create arrays to solve math problems) throughout the lessons to strengthen the learning of current math skills. A portion of students received additional support in small group and one-on-one help for missing math skills at least two to three times a week. All of which provided the ability to create more stimulating and meaningful activities (Lai & Hwang, 2016). Other students received activities and worksheet practice in more challenging skills for those who are above grade level at least three to four times a week (Araujo et al., 2017; Lai & Hwang, 2016). The four-week intervention covered the Eureka Math module 6 administration of the pretest and posttest.

Procedures

Students in both classes received the pretest, the Eureka Math End-of-Module 6 assessment, for the current math module through Edulastic (Edulastic, 2018; Eureka Math/Great Minds, 2018). Following the pretest students in the control group continued with the traditional instruction with the Eureka Math curriculum scripted lessons (i.e., structured lesson format guiding the teacher through fluency practice, teaching main content of lesson, and student practice with possible teacher dialogue and potential student responses). An independent observer used the fidelity checklist to ensure the teacher of the control group implemented the scripted math with fidelity. Students received one math lesson a day and a lesson aligned Eureka Math homework sheet to support each lesson. Students in the experimental group continued daily instruction in the flipped classroom (Araujo et al., 2017; Freeman, 2012; Lai & Hwang, 2016; Tucker, 2012) instruction model with Eureka Math (Eureka Math/Great Minds, 2018).

Students in the intervention group were introduced to the intervention prior to the start of research. Previous instruction to familiarize the students and families was essential to ensuring that the intervention would be used to fidelity. This decision was based on the age of the participants and the need for students and families to become familiar with the flipped classroom structure. Familiarization included logging into Google Classroom on a home device and troubleshooting technology issues. The researcher sent home detailed instructions on logging into Google Classroom. Additionally, the researcher checked with each student and their parent to help get each one connected on a device outside of school. Students were then assigned videos to test view-ability at home and to determine how many students watched them. Next, the researcher implemented the scoring and "mark as done" aspect in Google Classroom to more closely check that students were able to access and watch the videos at home. Furthermore, the Edpuzzle online tool was implemented to see exactly when students were accessing the videos and who was getting them done prior to the start of class. This was done to try and eliminate any possible technological barriers or misunderstandings in transitioning to the flipped classroom structure.

Once research started, students watched the videos that were posted on Google Classroom each night prior to a lesson. The next day students did the practice, what used to be homework, in class. Students participated in more independent, individualized, small group, project-based activities in class. At the end of the study, students in both the control group and experimental group received a posttest with the same Eureka Math End-of-Module 6 assessment reorganized with questions in a different order on Edulastic. This was to prevent memorization and provide validity and reliability.

Data collection. Data was collected with a pretest and posttest Eureka Math End-of-Module assessment (Eureka Math/Great Minds, 2018). It was collected using the Edulastic assessment program (Edulastic, 2018). No other data was collected.

Fidelity. Fidelity was monitored with an independent observer and a fidelity checklist. The researcher had an independent observer come into both experimental and control group classrooms. The independent observer checked each group 20% of the time with a fidelity checklist (see Appendix B) to ensure fidelity of the experimental and control groups and teachers to the research. All expected behaviors in both control group and experimental group were observed with 100% fidelity by the independent observer.

Ethical Considerations

In regard to respect for persons: when working with children, the researcher went through the informed consent process with parents/guardians. In consideration of the age of the students, they were debriefed on the study. In regard to integrity and justice: providing trustworthy and fair instruction and assessment practice. Students in both the control group and the treatment group used one-to-one devices in class. Additionally, the researcher made sure the final results were accurate and unaltered, there was correct citation of others' work in research of the intervention, and maintained confidentiality of students' scores.

Validity threats. A few potential extraneous variables were present. First was, if and how many students were out sick during the intervention and/or the assessments. Second was, field trip- time away from the material. Also, there was the possibility of students from the control group seeing the videos on a device outside of school hours from a student in the intervention group. Videos were posted to Google Classroom and were accessed at any time to view, pause, and rewind as often as needed. Some students may not have had availability to access internet or a computer at home. To address this, students were allotted time to view the video at the end of the day before going home. In addition, the video was available the next day before the follow up lesson practice while other students received additional time on online math practice programs. This was also done to help the students and parents become familiar with the flipped classroom structure and how to log on to Google Classroom on their choice of device at home. As there were two teachers involved, the first teacher was with the experimental group and the second teacher was with the control group there could be a difference in instruction between the two different teachers. Additionally, to limit personal bias the researcher did not grade the students' pre and posttests, they were electronically graded through the Edulastic digital program immediately (Edulastic, 2018).

Proposed Data Analyses

All data was entered into the Statistical Package for the Social Science®(SPSS®) for Windows, version 24.0.0 (SPSS, 2016). No names or identifying information was included in the data analysis. Before analyses was conducted all data was cleaned to ensure no outliers were present (Dimitrov, 2012). After cleaning the data, independent samples t-tests (control and treatment groups) and dependent samples t-tests (pretest and posttest) were conducted to determine the significant difference in mathematic benchmark scores between the two means scores on Edulastic (Edulastic, 2018). Further, before interpreting the analytical output, Levene's Homogeneity of Variance was examined to see if the assumption of equivalence had been violated (Levene, 1960). If Levene's Homogeneity of Variance was not violated (i.e., the variance was equal across groups), data was interpreted for the assumption of equivalence; however, if the variances were not equal across groups the corrected output was used for interpretation.

Results

Two independent samples t-test were conducted on the whole sample ($n = 44$) for both the pre and post assessment scores. Results for the pre-test were: Levene's Homogeneity of Variance was not violated ($p > .05$), meaning the variance between groups was not statistically different and no correction was needed and the t-test showed non-significant differences between the mean scores on the pre-tests between the two groups t (42) = -1.346, $p > .05$. This indicates that both groups (control mean: 4.03, experimental mean: 3.47) were similar or comparable with no statistically significant difference when the study started with the pretest (see Table 1). Results for the post-test were: Levene's Homogeneity of Variance was not violated ($p > .05$), meaning the variance between groups was not statistically different and no correction was need and the t-test showed non-significant differences between the mean scores on the post-tests between the two groups t (42) = -.674, p > .05. This indicates that both groups were similar and there was no statistically significant difference between groups (control mean: 4.95, experimental mean: 4.67) at the end of the study on the posttest (see Table 1).

Table 1

Results of Independent Samples T-Tests

	Mean	SD
Pre Test		
Experimental	3.47	1.17
Control	4.03	1.54
Post Test		
Experimental	4.67	1.41
Control	4.95	1.32

Note. SD = Standard Deviation.

After determining the differences between pre and post assessment scores between groups, two paired t-tests were run for both groups (i.e., experimental and control) to determine if participants mean scores from pre to post were significantly different within each group (See Table 2). Results for each group were as follows: experimental group, t (22) = -4.524, p <.001; control group, t (20) = -2.398, p <.05. This indicates that there were significant differences in both groups' scores between the pre and post-tests. Additionally, the negative t-value for each group indicates an increase in scores from pretest to posttest assessment. Meaning that both groups made improvements in their mathematics unit scores. Experimental pretest mean: 3.47 and posttest mean: 4.67 with an improvement of -1.20. Control pretest mean: 4.03 and posttest mean: 4.95 with an improvement of -.92. Even though the control group started and ended slightly higher than the experimental group, the experimental group had a higher amount of improvement from pretest to posttest (see Table 2).

Table 2

Results of Paired T-Tests

	Mean	SD
Experimental Group **		
Pre	3.47	1.17
Post	4.67	1.41
Control Group*		
Pre	4.03	1.54
Post	4.95	1.32

Note. SD = Standard Deviation. * = $p < .05$. **= $p < .001$.

Discussion

The study was implemented to determine if the flipped classroom instructional strategy would help improve the mathematical achievement for second grade elementary students. Few other studies have focused on the elementary setting (e.g., Lia & Hwang, 2016; Tsai, Shen, & Lu, 2015); therefore, this study explored whether implementing a flipped classroom would be a beneficial instructional strategy for younger students. The study included 46 students, 23 in the control group receiving traditional instruction and 23 in the experimental group receiving the flipped classroom instruction for a four-week intervention.

The results indicated that the experimental group made statistically significant gains on the math assessment with the use of flipped classroom. The experimental group had a larger gain in learning from pretest to posttest in comparison to the control group (experimental group: -1.2, control group: -0.9; see Table 2). The results support the idea that the use of the flipped classroom had a positive impact on student learning (Araujo et al., 2017; Kim et al., 2017). Based on these results, the hypothesis that second grade students receiving flipped classroom instruction will have greater improvement in their mathematics benchmark tests when compared to peers receiving traditional classroom instruction was upheld. The experimental group showed greater improvement from pretest to posttest. Though the experimental group did not score higher than the control group on the posttest; they did make greater overall improvement than the control group.

Although both treatment and control groups were similar, the control group started and ended higher than the experimental group noting that students made sufficient academic gains with the traditional teaching method. One possible interpretation could be that since the control group started higher, the experimental group had a larger gap to work with to raise their scores over the control group. These results are similar to previous studies on flipped classroom (Bhagat et al., 2016) and support that the flipped classroom instructional strategy can be beneficial in improving academics with second grade students as well as with younger students.

In connection and support from previous research, during the intervention the experimental group students had the opportunity to work independently, with peers, one-on-one with the teacher, or in small-groups (Araujo et al., 2017; Bhagat, Chang, & Chang, 2016; Freeman, 2012). Additionally, by having the instruction of the lesson in video format at home the previous night, which then provided more time in class, the students in the experimental group participated in more kinesthetic and project-based activities as supported in earlier research (Lai & Hwang, 2016). These activities supported and further enhanced the content students were exposed to through the videos watched at home and may have contributed to the increase in academic gains identified in this study.

Limitations and Future Studies

One of the more prevalent limitations was making sure students were watching the videos at home for homework as assigned. Both Edpuzzle and Google Classroom were used to help track student usage and to assign and deliver the videos. Once the students were out of the classroom it was challenging to get every student to watch the videos every day. This would take time from in-class activities by needing to have them watch the video in class. Additionally, if students did not watch the videos they would be behind on the content learned and not understanding the material in the in-class activities. Lai and Hwang (2016) indicated that students' outside-of-class learning and practices play a vital role and can impact the in-class activities. Furthermore, students who did not watch the videos as their homework made the instruction of the flipped classroom more challenging. These challenges included adjusting instructional time to allow students to watch videos in class before the practice/activity, backtracking for students asking questions about the content taught in the video, and having time to implement the activities planned for in-class; all of which have been noted in previous studies (i.e., Araujo et al., 2017).

Technology devices were another limitation as not all students had the same type of device or access to one consistently outside of the classroom. Students were also not able to take school issued devices home. In connection with consistent device usage outside of class, the same would be with parental support. Parents/guardians that made the video homework assignments a priority made a difference in in-class learning and activities and vice versa; as related to the research: those who did not do homework before mostly did not do it with flipped classroom (Araujo et al., 2017). Both the devices and parental support made accessing the material challenging for some students and not consistent.

A recommendation for future studies would be to implement a flipped classroom approach over an extended duration of time, such as the full school year. If the study was conducted throughout the school year, researchers would be able to assess the impact of a flipped classroom on all mathematical concepts.

In summary, the flipped classroom instructional strategy is a newer style of teaching that brings many positive possibilities and possible challenges to the classroom. The results of this study indicated that the flipped classroom did have a positive impact on elementary student learning and can be beneficial for younger students. As the use of technology expands, this additional teaching strategy is encouraging for elementary teachers to have as a tool to engage students in learning both in technology and mathematics.

References

Achievement. 2018. In *Merriam-Webster.com*. Retrieved December 13, 2018, from https://www.merriam-webster.com/dictionary/achievement

Akcayir, G. & Akcayir, M., (2018). The Flipped Classroom: A Review of its Advantages and Challenges. *Computers & Education*, 126, 334-345. doi:10.1016/j.compedu.2018.07.021

Araujo, Z., Otten, S., & Birisci, S. (2017). Mathematics teachers' motivations for, conceptions of, and experiences with flipped instruction. *Teaching and Teacher Education, 62*, 60-70. doi:10.1016/j.tate.2016.11.006

Bhagat, K. K., Chang, C. N., & Chang, C. Y. (2016). The impact of the flipped classroom on mathematics concept learning in high school. *Educational Technology & Society, 19* (3), 134-142. ISSN 1436-4522

Dimitrov, D. M. (2012). *Statistical methods for validation of assessment scale data in counseling and related fields*. Alexandria, VA: American Counseling Association.

Freeman, B. (2012). Using digital technologies to redress inequities for English Language Learners in the English speaking mathematics classroom. *Computers & Education An International Journal, 59,* 50-62. doi:10.1016/j.compedu.2011.11.003

Ed-Data. (2018). Name of School

Edpuzzle Inc. (2019) Retrieved from: https://edpuzzle.com/

Edulastic. (2018). Retrieved from: https://edulastic.com/

Eureka Math/Great Minds. (2018). Retrieved from: https://greatminds.org/math

Google Classroom. (2019). Retrieved from: https://classroom.google.com/u/1/c/MTQ5ODE2MjU2ODVa

Habecker, D. (2019). Duane Habecker. Retrieved from https://www.youtube.com/user/dhabecker/featured

Hwang, G., Lai, C. (2017). Facilitating and bridging out-of-class learning: an interactive E-book-based flipped learning approach for math courses. *Educational Technology & Society, 20*, 184-197. ISSN: 11763647

Kim, J., Park, H., Jang, M., & Nam, H. (2017). Exploring Flipped Classroom Effects on Second Language Learners' Cognitive Processing. *Foreign Language Annals, 50*, 260-284. doi:10.1111/flan.12260

Lai, C., Hwang, G. (2016). A Self-regulated flipped classroom approach to improving students' learning performance in a mathematics course. *Computers & Education an International Journal, 100,* 126-140. http://dx.doi.org/10.1016/j.compedu.2016.05.006

Levene, H. (1960). Robust tests for equality of variances. *Contributions to Probability and Statistics, 1*, 278-292.

Lo, C., Hew, K. (2017). A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. *Research and Practice in Technology Enhanced Learning*. doi:10.1186/s41039-016-0044-2

Lo, C., Hew, K., & Chen, G. (2017). Toward a set of design principles for mathematics flipped classrooms: A synthesis of research in mathematics education. *Educational Research Review,* 22, 50-73. doi:10.1016/j.edurev.2017.08.002

Mathematics. 2018. In *Merriam-Webster.com*. Retrieved December 13, 2018, from https://www.merriam-webster.com/dictionary/mathematics

Mattis, K. (2015). Flipped classroom versus traditional textbook instruction: Assessing accuracy and mental effort at different levels of mathematical complexity. *Technology, Knowledge and Learning*. doi:10.1007/s10758-014-9238-0

Schunk, D. (2016). *Learning theories: An educational perspective* (7th ed.). The University of North Carolina at Greensboro, United States of America; Pearson Education, Inc.

Tsai, C., Shen, P., & Lu, Y. (2015). The effects of problem-based learning with flipped classroom on elementary students' computing skills: a case study on the production of ebooks. *International Journal of Information and Communication Technology Education, 11*(2), 32-40

Tucker, B. (2012). The flipped classroom online instruction at home frees class time for learning. *Education Next, 12*(1),82-83*,* Retrieved from https://www.educationnext.org/theflipped-classroom/

Youtube, LLC. (2019). Retrieved from https://www.youtube.com/

Appendix A

Eureka Math End-of-Module Assessment through Edulastic

2/16/2019 Grade 2 Module 6 End-of-Module Assessment

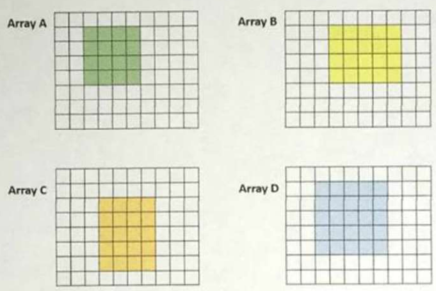
Edulastic

Grade 2 Module 6 End-of-Module Assessment

Collection: **Public**

Created by Eureka Math

Q1: Dee shades an array with 5 columns of 4 squares. Which array does Dee shade?



A Array A

B Array B

C Array C

D Array D

https://app.edulastic.com/secure/as/printPreview?t=1550360634026 1/8

2/16/2019 Grade 2 Module 6 End-of-Module Assessment

Q2: Juan draws a rectangle with 5 columns of 5. Then he separates 2 columns of 5 as shown.
Drag a number to each box to complete the number bond and repeated addition sentences for the two parts of Juan's rectangle.

DRAG DROP VALUES

2

3

5

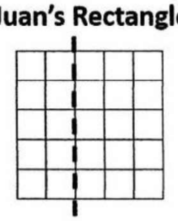
8

10

15

25

Juan's Rectangle



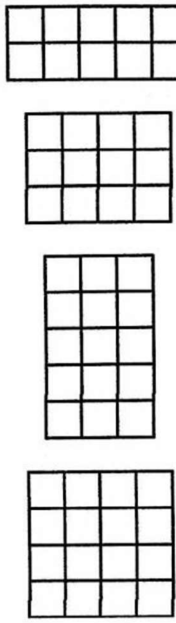
5 columns of 5

2 columns of 5 □ columns of □

□ + □ = □ □ + □ + □ = □

https://app.edulastic.com/secure/as/printPreview?t=1550360634026 2/8

Q3: Joana made four arrays with different numbers of square tiles as shown.
Match each array with the number sentence that shows the total number of tiles it contains.



ANSWER CHOICES

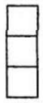
$4 + 4 + 4 = 12$

$5 + 5 = 10$

$3 + 3 + 3 + 3 + 3 = 15$

$4 + 4 + 4 + 4 = 16$

Q4: One column of an array using square tiles is shown. Damon adds 3 more columns of square tiles to the array.



Which repeated addition sentence shows how to find the total number of square tiles in Damon's new array?
Use paper to show your work. Select the correct answer.

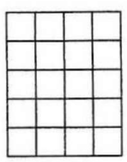
A $3+3+3=9$

B $1+1+1+1+1+1=6$

C $3+3+3+3=12$

D $4+4+4+4=16$

Q5: An array of squares is shown.



If 1 column is removed, which array would be left with the remaining squares?
Use paper to show your work. Select the correct answer.

A 3 rows of 5

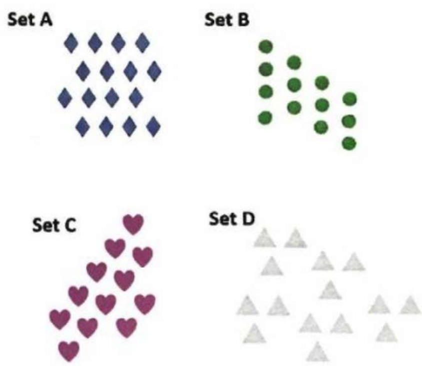
B 5 rows of 3

C 4 rows of 3

D 4 rows of 4

2/16/2019 Grade 2 Module 6 End-of-Module Assessment

Q6: Which sets of objects show an odd number? Select the two correct answers.



A Set A

B Set B

C Set C

D Set D

https://app.edulastic.com/secure/as/printPreview?t=1550360634026 5/8

Q7: Drag a number to each box to create true number sentences. Then, complete the statements to match using "odd" or "even."
The first row is completed as an example.

DRAG DROP VALUES

12

14

15

16

18

20

odd

even

Number Sentence	Statement
12 + 5 = 17	even + odd = odd
6 + 6 = ☐	☐ + ☐ = ☐
12 + 3 = ☐	☐ + ☐ = ☐
7 + 9 = ☐	☐ + ☐ = ☐
19 + 1 = ☐	☐ + ☐ = ☐

2/16/2019 Grade 2 Module 6 End-of-Module Assessment

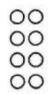
Q8: Drag a word to each box to correctly complete each statement.

DRAG DROP VALUES

even

odd

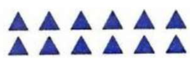
a.



The number of circles in the array is ☐.

If 1 circle is removed from the array, the new number of circles will be ☐.

b.



The number of triangles in the array is ☐.

If 1 triangle is added to the array, the new number of triangles will be ☐.

c.

The number of stars in the array is ☐.

If 2 stars are removed from the array, the new number of stars will be ☐.

Answer Key of Grade 2 Module 6 End-of-Module Assessment

1. B

2. Tech Enhanced Item

3. Tech Enhanced Item

4. C

5. B

6. B,D

7. Tech Enhanced Item

8. Tech Enhanced Item

Appendix B

Observer Fidelity Checklist

Date	Treatment/Control	Signature/Initial

Control Group:

- teacher is teaching from the Eureka Math Module 6 Curriculum TE

Yes No

- teacher is not using outside resources including: supplemental worksheets, kinesthetic activities, and project-based activities

Yes No

- students are working from Eureka Math Module 6 Curriculum consumable books/sprints/fluencies

Yes No

- students are not being taught through online or teacher made videos

Yes No

- students are not assigned online or teacher made videos for homework

Yes No

Treatment Group:

- students have access & watch videos on Google Classroom assigned as homework

Yes No

- students are working in whole group/small group/ individual work with consumable books/sprints/fluencies

Yes No

- project based activity in progress

Yes No

- kinesthetic based activity in progress

Yes No