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Examining Implementations of Blended Learning in a K-12 Mathematics Classroom

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Introduction

Online learning systems have been infiltrating higher education at an ever-increasing rate, particularly over the last decade (Garrison & Kanuka, 2004). Students of all ages, cultural backgrounds, marital statuses, and living situations attend higher education institutions. As student populations become more diverse, the demand for universities to provide flexible scheduling options continues to escalate. Online learning forums allow for students to complete their coursework at various locations and times. In addition, online teachers have access to a number of interactive learning modules and activities that are not typically available during face-to-face instruction. These online tools offer students an opportunity to regularly become individually engaged in the material of the course. Some administrators and instructors argue face-to-face instruction cannot ever be successfully replaced by online instruction because online learning eliminates the benefits of human interaction in the learning process (Picciano & Seaman, 2009). As a result, other learning systems have begun emerging in higher education that include both online and face-to-face strategies.

Learning systems that incorporate both online and face-to-face instruction (aka hybrid instruction) are referred to as *blended learning systems*. According to John Watson (2008), the founder of the Evergreen Education Group, blended learning systems bring forth the best aspects of both online and traditional forums. Students in a blended course have more flexible coursework schedules than students in a traditional course, yet students still experience the face-to-face communication that is lost in online forums. Although the number of students enrolled in online courses is greater than students enrolled in blended courses, the rate at which students are enrolling in blended courses is rapidly increasing (Picciano & Seaman, 2009). Researchers cannot pinpoint one specific cause of this gap between online and blended course enrollment, yet the most frequently cited reason is limited availability to blended courses in the K-12 setting. Students do not necessarily get to select the course format – face-to-face, online, or blended – that best meets their educational and personal needs. Many K-12 schools only offer one or two options for course formatting due to inadequate access to technological and educational resources, which often leaves the students with minimal influence on their course scheduling. Students can participate in fully online courses or blended courses to accommodate their busy schedules at the post-secondary level. This begs the question: What about students at the K-12 level?

K-12 students have a fairly rigid school schedule during the week. Teachers' responsibilities include but are not limited to collecting homework, teaching the course content, presenting interactive activities for students, assigning homework, administering and scoring tests, quizzes, or other formative assessments, promoting student discussion, and more on a regular basis. Daily class meetings may be as short as 42 minutes. This challenges teachers to fully engage their students and promote student creativity in the classroom given the breadth of activities and short time period.

Implementing fully online strategies would be difficult in the K-12 classroom for several reasons, including concerns about losing local, state, and/or federal funding based on student attendance (Picciano & Seaman, 2009). K-12 schools would still need funds to establish, facilitate, and maintain fully online courses, even though fewer students would be physically attending the school. A focus of this investigation was to explore blended learning strategies in the K-12 mathematics classroom. Blended learning in the K-12 classroom allows teachers to optimize their in-class time while using the online portion to access tools that are otherwise unavailable. In the classroom setting, students could participate in meaningful face-to-face discussions and hands-on activities. When students leave the classroom, they might complete more procedural tasks online, like standardized test practice and practicing exercises. The online forum might give students access to external links for additional help, supplemental videos and modules, and other interactive activities. Blended learning certainly has a practical application in the K-12 classroom. My research investigates the implementation of blended learning strategies in one middle school mathematics classroom.

Related Literature of Blended Learning

Defining and Characterizing Blended Learning

Defining blended learning proves to be a rather complex endeavor since various people defined it differently. Picciano (2009) claims that blended learning encompasses all possible ranges of combining conventional face-to-face instruction and online instruction as long as both learning forums are present in some form. I will utilize this characterization of blended learning for my project. A blended learning course is not sufficient with simply one learning environment since both forums work in tandem. Watson, Murin, Vashaw, Gemin, and Rapp (2010) remind us that, "although technology is important to online learning, it is crucial not to overstate its role. In the online environment teachers and students are still the primary players; the technology plays a supporting role" (p. 9). Therefore, the success of every blended learning system, regardless of the format, relies primarily on the community formed by the interaction between students and teachers.

Blended learning systems can be organized and presented in a variety of ways. Four different models of blended learning are present in K-12 education today: rotation, flex, self-blend, and enriched-virtual models (Staker & Horn, 2012). The rotation model is a blended program in which the teacher determines a fixed schedule to operate between learning forums, as long as at least one is online (Staker & Horn, 2012). The rotation model is further parsed into the station-rotation model, the lab-rotation model, the flipped-classroom model, and the individual-rotation model. This research project utilizes the rotation model, specifically the station-rotation model, for the blended learning course. Students alternate between online and face-to-face learning forums on a fixed schedule. "The rotation includes at least one station for online learning. Other stations might include activities such as small-group or full-class instruction, group projects, individual tutoring, and pencil-and-paper assignments" (Staker & Horn, 2012, p. 8). The station-rotation model is very applicable to the K-12 educational system since face-to-face time already designated by the school can be utilized for full-class instruction or small-group activities. When students leave school for the day, their home operates as the station where they can engage in the online component of the course. Not only is the application of blended learning strategies in the K-12 classroom practical, but it is also beneficial (Bonk, Olson, Wisher, & Orvis, 2002).

Benefits of Blended Learning

There are multiple reasons to utilize blended learning strategies. Blended learning effectively brings together the best of both face-to-face and online learning forums. Benefits include cost effectiveness, flexibility, peer collaboration, and communication (Bonk, Olson, Wisher, & Orvis, 2002). They are cost effective for educational institutions by allowing certain programs to increase the student-to-teacher ratio, if they are able to implement a rotation schedule where groups of students meet for the face-to-face portion of blended instruction at different times and/or on different days. Additionally, these schools can incorporate free and/or reusable resources that would otherwise be unavailable through purely face-to-face instruction. For example, instead of purchasing deceased frogs on a yearly basis for students to dissect in

Biology class, a school could purchase virtual frog dissection software for all students to use over the course of several years. It has "been shown that when students are offered an alternative to dissection using models and charts, there was no significant difference in their written examination results, in particular on those based on the dissection, compared to students who completed the dissection" (Franklin, Peat, & Lewis, 2002, p. 61).

Also, blended learning systems offer flexibility in a multitude of aspects in the classroom such as content, design, location, and pace (Bonk, Olson, Wisher, & Orvis, 2002). Teachers have more opportunities to provide supplementary material outside of the standard material covered solely in face-to-face instruction. They have flexibility in deciding how and where to present that material to their students, whether they choose mediums like in-class lectures, online readings, hands-on activities, and/or interactive software. Blended learning systems promote peer collaboration and communication through the use of online discussion boards and collaborative group projects. Even though blended learning is becoming more prevalent in higher education, many K-12 administrators still have concerns about implementing blended learning strategies.

During the 2007-2008 academic year, a national survey of school district administrators was conducted to gather information about perceived benefits and concerns when incorporating online and/or blended strategies in the K-12 classroom. Out of approximately 16,000 schools nationwide, eight hundred and sixty-seven administrators responded to the survey (Picciano & Seaman, 2009). Results of that survey revealed the majority of school administrators at the time felt the most significant advantage of having access to online and blended learning programs was that courses could be offered that would not otherwise be available at the school (Picciano & Seaman, 2009). Schools may not be able to offer certain courses for a number of reasons including unqualified teachers in specific content areas and too few interested students. For instance, blended learning systems allow school districts to provide their students with higher-level courses for college credit by obtaining access to essential resources through the online forums of colleges or other school districts. Students with limited financial and transportation means would still be able to participate in higher-level learning because these blended courses would be available directly within the confines of their school.

Blended learning systems can eliminate some of the menial aspects of teaching such as copying papers (Tucker, 2012). Additionally, blended learning systems create the opportunity to let students practice standardized test questions online instead of during in-class time (Tucker, 2012). This frees up time during face-to-face instruction for the teacher to facilitate in-class discussions about new material, answer any questions students may have, and incorporate interactive activities.

Blended learning systems have the propensity to lead to more personalized pedagogy and greater access to high-quality teachers (Horn & Staker, 2011). Teachers have access to different mediums to present information in blended learning classrooms that are not accessible in a conventional classroom. Additionally, teachers may be able to provide various presentations of the same material online so the students are able to choose how they would like to learn the content. Students could choose to learn about a given topic by watching a recorded lecture, reading a PowerPoint presentation, or completing an interactive module.

High-quality teachers can find their way into a K-12 blended classroom indirectly through lectures over the Internet when the regular classroom teacher chooses to incorporate these lectures via Skype or YouTube within his/her lesson. As blended learning is implemented in K-12 classrooms, Watson (2008) predicts that teachers will have to take on the roles of guide and mentor rather than merely act as an information disseminator. The role of guide and mentor during instruction is supported by major organizations including the National Council of Teachers of Mathematics (2014, 2007, 2000). Incentives such as frequent feedback, relevant connections to material, engaging activities, and opportunities to interact with peers, play an important role in motivating students in a blended learning classroom (Bonk, Olson, Wisher, & Orvis, 2002). Online educational forums require student self-discipline, organization, and punctuality more than face-to-face forums. Incentives provide motivation for these students to always stay on top of their online assignments and assessments, as well as to become fully engaged in the course material. The prospective positive outcomes previously discussed may never come to fruition until these aspects are integrated seamlessly in a blended learning system.

An Example of Blended Learning in K-12 Learning Environments

These benefits for college-age students hold in a blended, high school mathematics classroom. I drew upon one study of Algebra I learning as a guide when constructing my research project about blended learning in a high school mathematics classroom and analyzing results from it. This investigation compares a treatment group that was enrolled in a blended instruction environment and a comparison group that experienced traditional face-to-face instruction (O'Dwyer, Carey, & Kleiman, 2007). The researchers collected both qualitative and quantitative data for their mixed-methods study. Quantitatively, the researchers contrasted growth in students' mean scores on an Algebra pre- and post-test in order to measure the amount of content learned during the course, and examined the variance in groups' test scores. Students in the treatment group performed better than the comparison group students on the real-world application portion of the measure, as well as on eighteen of the twenty-five items on the post-test (O'Dwyer, Carey, & Kleiman, 2007). The researchers conducted a number of surveys for the students in both groups to complete regarding confidence in algebra skills, confidence in technological skills, and preference of blended or face-to-face instruction. These latter qualitative data were meant to support the quantitative findings. Survey results showed that students in the treatment group enjoyed using technology to learn mathematics (O'Dwyer, Carey, & Kleiman, 2007). Unfortunately, a higher percentage of students in the treatment group did not feel confident in their algebra skills after the course or reported having a poor learning experience (O'Dwyer, Carey, & Kleiman, 2007). An explanation was offered for this lack of confidence. Many students may have reported feeling less confident in their Algebra skills because they were still trying to get accustomed to the new style of instruction.

A second example of K-12 classrooms implementing blended learning occurred in a mathematics classroom at Purcell Marian High School. Recently, "the roughly 400-student school announced this week that not only do students like the program, several have zoomed through the entire math course in just one quarter" (Brown, 2013, par. 4). Teachers were able to work face-to-face with students that were struggling individually or in small groups. This blended learning system allowed for the school to "better serve students at different learning levels" (Brown, 2013, par. 9). Thus, blended learning systems can indeed provide more enriching and constructive educational experiences than traditional face-to-face instruction alone for students in the K-12 setting.

Connection to the Present Study

I used the station-rotation model to structure my blended learning course. My students met during the scheduled school period for full-class instruction and small group work. They accessed the online portion of the course to complete activities and assessments outside of the face-to-face instruction. Also, students had access to a variety of different lecture materials and supplementary links on the online forum. I employed a variety of incentives such as real-life applications, Algebra-focused games, and hands-on activities to motivate my students. My primary influences when designing my research method are the Louisiana Algebra I study and Purcell Marian High School. I will utilize a series of pre- and post-tests to show student learning growth between traditional and blended units similar to those of the Louisiana Algebra I study. Like Purcell Marian High School, I will provide a variety of resources to support students of all different learning levels. Both of these resources have provided significant support to the claim that blended learning is successful in the K-12 classroom. My research questions are: How does the performance of students taught using face-to-face methods compare to performance of the same students taught using blended methods on a content-focused measure? Also, what are students' perceptions of blended learning?

Method

Context and Participants

I worked with my Algebra I class of 17 students. The placement school that I am currently working in with these students is in a rural area of Ohio, which upholds a strong sense of community yet provides limited access to educational technologies. The ages of the eighth-grade participants are between twelve and fourteen years old. Students had to perform well on an Algebra placement test in seventh grade as well as have a history of exemplary grades in previous mathematics courses in order to be placed in the Algebra I class. My participant group was composed of the highest-achieving mathematics students in the eighth-grade class. All participants, however, did have some means to access our blended activities and assignments, such as phones and mp3 players with internet capabilities.

Procedure

My blended action research was split into two primary units: a face-to-face unit and a blended unit. Students first learned in an entirely face-to-face manner, which means that no online instruction was added at this point. Then, students were taught the next unit in a blended fashion, meaning that students used an online forum of learning in addition to the traditional face-to-face classroom component. The duration of this research study was two months, which accounted for both the traditional and blended units.

I administered a series of three identical ten-item multiple choice tests to gather quantitative data and one ten-item survey to gather qualitative data to illustrate student growth throughout the traditional and blended units. The first test was given before either unit was started, the next test was given immediately after the traditional unit had been concluded, and the final test was given as soon as the blended unit was finished. As shown in the Appendix, the tests were composed of the same ten multiple-choice questions, which dealt with Algebra content covered before either unit, during the traditional unit, during the blended unit, and after the blended unit. Students took approximately thirty-five minutes to complete each test because many questions had multi-step solutions. Also, the testing structure was formatted using a pre-test, post-traditional test, and post-blended test because I only had one group of participants. I could not set up an experimental group and a control group to compare results, so I had to configure a series of identical tests to compare learning growth within the one participant group.

I utilized the online interface Edmodo (www.edmodo.com) to create this blended learning course. Edmodo provided structure and accessibility to the online course material and assessments for the students. Students had to sign up for a free account on Edmodo, but the students did not need an email address or significant personal information to do this. Students could enroll in my online course by following a link I provided for them once an account had been created. Edmodo provided students access to links to extra help for homework, a discussion board where student could ask questions and converse with one another and the instructor about mathematical concepts, videos that introduced new topics that were discussed in more detail during face-to-face instruction, missed assignments that assisted absent students in catching up, polls that gauged student mastery at a specific checkpoint in the unit, and other interactive tools like online graphers. Most assignment materials posted to Edmodo for the blended course were free, public, and content-rich videos and games. I created all supplemental materials though, such as discussion questions and guided notes. Edmodo's layout is quite similar to the popular social media website Facebook, so most students found navigating Edmodo's class "wall" and folders practically second-nature. Also, Edmodo has an application that can be downloaded for free onto a smartphone or other device to provide mobile-friendly access to all assignments and discussions on the class site.

Picciano's (2009) Multimodal Model depicts six pedagogical objectives that are absolutely vital for the success of any course: content, reflection, growth/development, dialectic/questioning, collaboration/student generated content, and synthesis/evaluation. The blended course, as well as the students, exhibited all six of these pedagogical objectives. Students learned the mathematical content predominantly during the face-to-face instructional period, yet they also learned content through instructional YouTube videos with guided questions to complete for homework. Additionally, for review purposes, they had access to lectures and additional materials on the Edmodo site. They gained social and emotional support and contact during the face-to-face portion of the course from the instructor and their peers. Students were able to reflect on what they have learned via online discussion board posts and follow-up questions. Students collaborated with other students during group assignments that effectively used the face-to-face instruction time, in addition to chatting through the discussion board. The discussion board provided a common place for students to ask questions about the material covered both in the classroom and online to their peers and instructor. Students were evaluated in this course by tests and quizzes. Some of these assessments were completed in the classroom, while other quizzes and tests were given online.

Data Collection

Both quantitative and qualitative data were collected for this mixed-methods research on blended learning. Students were asked to complete a test about mathematical concepts at three time points. The concepts were organized into four parts: (a) those previously covered, (b) those covered during the face-to-face unit, (c) those covered during the blended unit, and (d) those covered in units following the blended unit. Out of ten questions, two questions addressed part (a), three questions addressed part (b), three questions addressed part (c), and two questions addressed part (d). The multiple-choice test included an "I don't know" option. The first administration was at the beginning of the project. After the face-to-face unit, students were asked to complete the same measure after the face-to-face unit. Next, students completed the measure a final time after the blended unit. Growth in students' test scores was compared within the group for all three tests. I encouraged students to attempt the problem if they had any inkling of how to solve it. I discouraged students from simply guessing answers. I would have rather been informed that a student did not know how to attempt a question than have assumed the student understood the material because he/she guessed the correct answer on the tests. I also gathered qualitative data through a survey. The survey contained questions about mathematics skills learned during the unit and preference of instruction. Some survey questions were "How do you feel about the communication features available in an online setting?", "How do you feel this blended learning experience in Algebra affected your learning?", and "From this point forward, how would you like to do homework in this class?".

Data Analysis

I found the mean and the standard deviation of the pre-test, post-traditional test, and post-blended test scores to analyze my quantitative data. Also, I employed three paired-samples t-tests to determine within-group changes in test performance. First of all, I paired the scores from the first and second measure administration to examine growth after the traditional unit. Then, I paired the scores from the second and third measure administration to explore growth after the blended unit. Lastly, I paired the scores from the first and third measure administration to investigate the overall degree of learned content throughout the research project. I was able to compare the overall growth for each group by finding the difference between the mean of the post-test scores and the mean of the pre-test scores. Also, the standard deviation provided insight into the variability during each test administration.

The participants completed the survey online using SurveyMonkey (www.surveymonkey.com). I utilized Miles and Huberman's framework to analyze my qualitative data, express my results meaningfully, and draw conclusions (Berkowitz, 1997). SurveyMonkey automatically organized the responses from both participant groups and filtered them to address each question in the surveys during the data reduction process. I exported my data from SurveyMonkey to Microsoft Word. I created tables of the survey data to visually explore my data. These tables enabled me to compare survey responses from within the participant group, as well as to deduce logical patterns and interrelationships present in the data set (Berkowitz, 1997, par. 16). I have drawn conclusions from these relationships and verified my data once I find relationships within the qualitative data. The relationships between participant survey responses indicated whether these students preferred learning mathematics in a blended classroom or in a conventional classroom. I was able to conclude whether or not blended learning systems can be effective in an eighth grade mathematics classroom based on the results. I constantly revisited my qualitative data to ensure my conclusions were valid (Berkowitz, 1997).

Results

Data analyses in this blended learning research focused on 17 participants' mean scores as a class on a series of identical tests, as well as the standard deviation, as it relates to student learning growth. Three paired-samples t-tests were conducted to compare student growth after face-to-face instruction, after blended instruction, and over the duration of the research project. As illustrated in *Figure 1*, the mean score for the pre-test was 4.06 out of 10 possible points. The students improved on an identical test by almost 10% with a mean score of 4.94 out of 10 possible points after the face-to-face unit. Finally, the students showed growth of approximately 25% from the previous measure after the blended unit with a mean score of 7.59 out of 10 possible points. In sum, they gained on average .84 points between the first and second administration and 2.62 points between the second and third administration. The students exhibited learning growth of approximately 35% between the pre-test and post-test after the blended instruction. The standard deviations of each test throughout the research is as follows: 1.48 for the pre-test, 1.56 for the first post-test, and 1.12 for the second post-test. The variance in scores was the least during the final administration of the measure, which also happened to be following the blended unit.

To compare student growth throughout the research project, I conducted a paired-samples t-test with three pairs by comparing (i) the scores from the first and second administration to explore growth after the face-to-face unit, (ii) the second and third measure administration to investigate growth after the blended unit, and finally, I compared (iii) the scores from the first and third measure administration to characterize to what degree students learned content during this research project. Regarding the first comparison (i), the t-test was significant, $t(16) = 6.06$. For the second comparison (ii), the t-test was significant, $t(16) = 7.29$. The third comparison (iii) t-test was also significant, $t(16) = 9.95$, $p<0.001$. With the significant increase in t-score, the data are quite clear in illustrating that student growth improved more substantially with the blended instruction approach than with the face-to-face instruction.

I gathered qualitative data through a ten-item survey on SurveyMonkey to support my quantitative data. Before the blended unit, I gathered that many students had a very negative impression of learning mathematics through online materials through informal conversations with students. After the blended unit, however, the qualitative data gathered in the surveys regarding learning mathematics online was overwhelmingly positive, which complimented the quantitative data as well. Fifty-nine percent of students rated the experience either "extremely positively" or "quite positively" when asked how they felt the blended experience affected their learning in Algebra. No participants claimed feeling that the blended experience affected their learning in a negative manner. Some students mentioned specific reasons why they felt the blended experience was beneficial, such as the following student who said, "Watching a video on some of the subjects before introducing it in the actual classroom is extremely helpful because it gives the students a general idea of what will be practiced in class." Similarly, one hundred percent of participants rated the overall blended experience as "excellent" or "very good". One student said, "It is really hard to come up with visual aids for math than other subjects, and I feel that playing a short game or watching a short video can have a positive effect on a student's ability to apply and learn the skills." Other students cited various reasons for feeling so positively about the blended experience, which included ease of assess of materials from electronic devices, engaging learning activities and homework assignments, and instant communication with peers and teachers. One student cited a benefit of the blended format by saying, "You can ask the teacher for help if needed and there are videos or website links to help most of the time." Half of the students felt that the online assignments were neither too easy nor too challenging, while the other half represented an even split between quite easy and quite challenging. These students had never experienced any online mathematics assignments before this blended experience, yet they had taken the online PARCC tests in mid-February. After the blended experience, thirty-five percent of the students said that they would prefer an evenly split mix of online and paper-and-pencil assignments from this point forward. In addition, forty-seven percent of students claimed they would actually prefer mostly online assignments with fewer paper-and-pencil assignments.

Quantitative data, although concrete evidence of growth, does not represent the entire learning process by itself. Qualitative data gathered from the survey accounts for student interests, attitudes, and emotions. Students must be active participants in their own learning, which requires teachers to pique the interest of their students by accommodating the specific needs of our varied student population. My students are growing up in a society immersed in technology. Why should society give students access to powerful resources then ban or not use them during instruction? We, as teachers, must learn to utilize technology in a positive manner since students will be tempted to use it during class anyways. It is amazing how much students' opinions of technology in the mathematics classroom changed before the survey about the blended experience knowing that they had such a negative view about technology in the mathematics classroom before the blended unit. Most students rated the blended learning experience as a positive endeavor in Algebra class with a plethora of supporting reasons. Some students preferred learning mathematics with an online component because “[they] were able to learn mathematics in a different way than [they] ever had before.” Others stated that they felt “closer to [their] peers because [they] were able to help each other through common problems.” Therefore, the blended learning experience helped my students evolve as mathematicians, problem-solvers, technology-users, and classmates.

Discussion

Both the Louisiana Algebra I experiment and Purcell Marian High School gave me the inspiration to test blended learning in my eighth-grade classroom with hope that it would show a significant increase in my students’ learning growth. The combination of my quantitative and qualitative research certainly shows a significant increase in learning growth, as well as a positive shift in attitude towards online learning in mathematics. The statistics show that student growth after the blended unit nearly tripled as compared to growth after the traditional unit. At Purcell Marian High School, students were able to zoom through the mathematics course due to their increase in growth rate, as well as their retention of previous material. My students ultimately showed similar outcomes through the blended learning experience, yet the experimental unit only spanned about one month’s time. I witnessed firsthand how blended learning may help advance students through material with similar or better comprehension at a much quicker pace, but I was unable to test whether this trend held true in the long-term.

Negative attitudes towards learning mathematics on any online platform were abundant in my classroom before we began the blended learning process. Similar feelings were even cited after blended instruction in the Louisiana Algebra I study. In Louisiana, most students reported a poor learning experience and a lack of confidence in their technological skills. The researchers, however, attributed these negative feelings to anxiety about adapting to a new learning format. Interestingly enough, my students displayed a one-hundred eighty degree shift in attitude towards learning mathematics online and their technical skills. My students were reluctant to begin the blended learning course and attempted to convince me to reconsider using blended strategies at all. One student said, “I am not good with technology… Anyways, why can’t we just use paper-and-pencil?” Another student echoed, “Yeah, I don’t like math online. It’s going to be just like those PARCC tests…” The students had intensely malignant feelings towards learning mathematics online because they had recently been tested yet never learned in that format, which was a stressful and nerve-wracking experience for them. Ultimately, students were concerned that their grades would significantly suffer from the online portion of the course, as well as their workloads would become substantially heavier. Students soon became acclimated to the blended format and realized that the online materials were to supplement classroom activities rather than replace them. Positive attitudes began surfacing after students grasped that incorporating online components in a mathematics course gave them access to engaging materials that would otherwise be unavailable. Students began to moan and groan when paper-and-pencil homework was assigned because they started to prefer watching mathematics videos or playing content-based games online. The vast majority of students rated the blended learning experience as “excellent” or “good,” as opposed to the Louisiana Algebra I study findings. Additionally, many students cited feeling that their technology skills in mathematics were enhanced after the blended learning activities.

In accordance with the research from my literary review, the greatest triumph was the classroom community that blossomed as a result of the blended course format. Struggling students were able to post questions to the class wall on Edmodo, rather than wait until the next day when they would have most likely forgotten them. My students began communicating with me, as well as their peers, regularly about homework challenges and technology problems even though Edmodo posts were not anonymous. This extended communication outside of class gave me time to prepare solutions and extensions before the students even entered the classroom on the next day. Students posting questions on a class wall showed other students in the class that having questions and making mistakes is acceptable in our classroom community, and we should be willing to work through those challenges as a collective team. Then, I could hardly log on to Edmodo soon enough to answer student questions because other students began taking the initiative to help their peers. Therefore, the role of classroom leader dissolved and I took on the role of being a class mediator. This camaraderie between students carried into the classroom, as students started offering to answer each other's questions and politely correct each other's mistakes.

Limitations

There are several limitations to my research that are worth noting despite the overwhelmingly positive results of my blended experiment. First of all, I initially planned on examining two classes for my blended research before I learned of my student teaching placement. One group would have been the treatment group, which would have learned all material in a unit using blended strategies. The other group would have been the comparison group, which would have continued to learn all material in a unit using traditional face-to-face strategies. My rural placement district, however, has a student demographic that is predominantly of low-socioeconomic status. With that, the school technological resources are also limited. A single class set of laptops is all that the school has to offer students and laptops are rented out by teachers at least a few months in advance. Borrowing laptops for a class multiple times during the week throughout the course of this experiment would have been technically impossible, not to mention frowned upon. Only one class had enough students with access to internet after school out of all four possible classes. This class happened to be the eighth-grade Algebra class, which is composed of the top-performing mathematics students in the entire grade. Unfortunately, this class is the only section of Algebra that I taught, so I had no way of crafting a comparison group. Therefore, I had to alter the format of my research in order to accommodate the needs and technological capabilities of my students.

Technological difficulties were abundant throughout the blended portion of the experiment. The vast majority of students had little to no difficultly when loading the webpages and tools required to complete the online assignments, yet each assignment had a few students claiming to have experienced technological trouble. For instance, students were to play a mathematics game for an assignment and take a screenshot of their results. Most students successfully completed the assignment, but some students were unable to load the game due to outdated Java. Other technological difficulties were due to user error. A few students had issues completing and loading assignments because they did not follow the verbal directions in class and the written directions on Edmodo. A video assignment with follow-up questions, for example, proved challenging for a few students. The students claimed to not know how to submit the assignment, even though we discussed the procedure in class and written directions were available on Edmodo. Lastly, all students had electronic devices required to complete the assignments, such as phones, mp3 players, and laptops; however, a few students did not have any access to the internet at home. These students were often able to complete the assignments at school during a study hall using the school's wireless internet, yet the wireless internet failed to function properly on several occasions. The malfunctions led to several students needing alternate assignments in order to receive credit for completing their homework.

Winter weather caused a significant amount of calamity days during my blended experiment, which pushed back many deadlines throughout my research. Students also missed several days' worth of lessons due to testing schedules, short field trips, and a class trip to Washington D.C. in addition to the calamity days. I had anticipated starting the traditional face-to-face unit in late January and the blended unit to follow in early March during the planning phase of my research. Instead, I was unable to start my traditional unit until February 17th, which delayed the start of my blended unit until March 17th. Most lesson plans had to be condensed and reworked to accommodate the imminent time crunch. Therefore, many exploration activities I had originally planned in-class had to be shortened or cut out completely.

In this research project, I investigated the effects on eighth grade students' performances and perceptions throughout a blended learning experience by implementing a combination of face-to-face and online instructional strategies in an Algebra classroom. This blended experience was segmented into two units – a face-to-face unit and a blended unit – to allow for comparison within the participant group of high-achieving mathematics students. Edmodo, an online educational platform, was utilized to provide students with access to online resources at home during the blended unit. Students completed a series of three identical tests to quantitatively measure learning growth at designated checkpoints throughout the experience, specifically before either unit, after the face-to-face unit, and after the blended unit. To gather qualitative data, students also responded to a ten-question survey after the blended unit to discuss the evolution of their perceptions of blended learning strategies in the mathematics classroom.

My students exhibited learning growth approximately three times greater after the blended unit than they had shown after the face-to-face unit. Additionally, my students' perceptions of blended learning in a mathematics classroom changed dramatically in a positive way once both units had been concluded. One other noteworthy achievement of the blended learning system was the thriving classroom community that developed due to the regular mathematical discourse with peers outside of the physical classroom.

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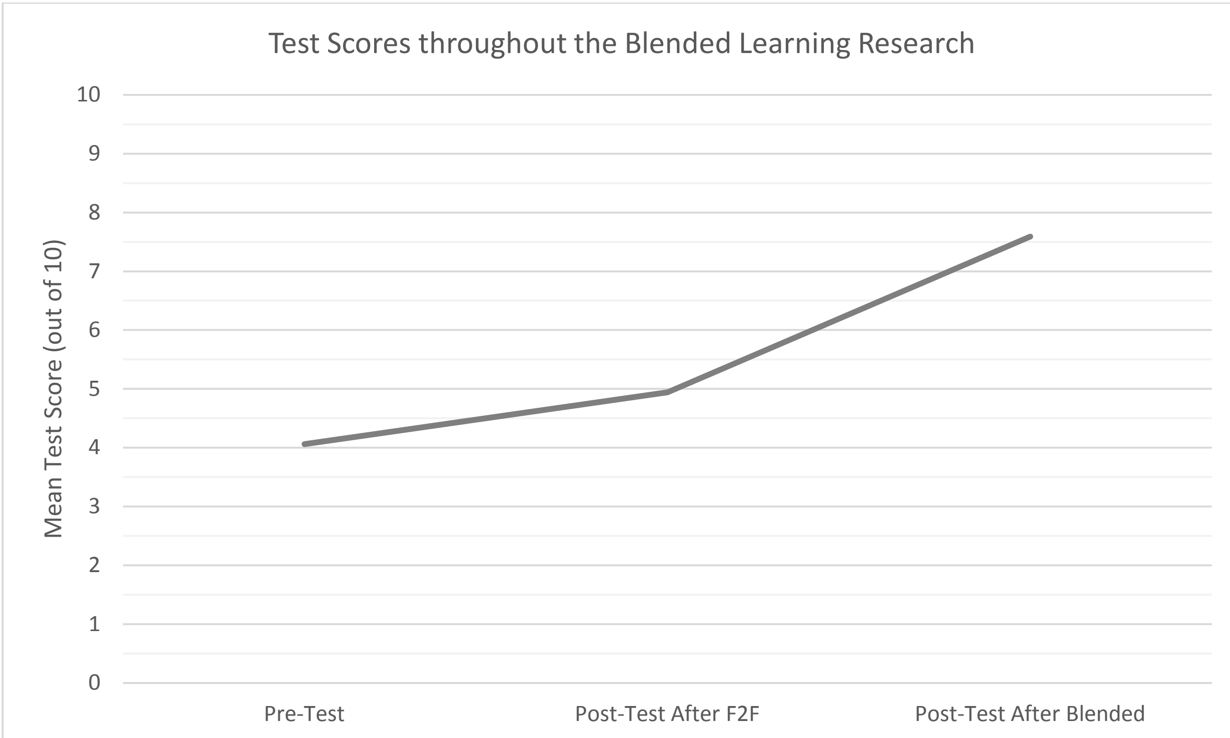

Figure 1. The line graph above depicts the student learning growth measured by a series of tests at certain checkpoints throughout the research, specifically before either unit, after the face-to-face unit, and after the blended unit. For each of these three tests above, the mean score of the entire class has been used to generate this graphic. The test at each checkpoint was out of 10 possible points. The mean score of the pre-test was 4.06. After the face-to-face unit, the participants' mean score was 4.94. Finally, after the blended unit, the mean score of the class was 7.59.

Appendix. *Below is a copy of the ten-question test that was used for the quantitative measure.*

Name: ______________________________

Algebra Pre-Test

Directions: For each question, select one answer by circling its corresponding letter. Show any work!

1. Since its creation 5 years ago, approximately 2.504×10^7 items have been sold or traded on a popular online website. What is the average daily number of items sold or traded over the 5-year period?
   a. about 5,008,000 items per day
   b. about 1,025,000 items per day
   c. about 13,720 items per day
   d. I don't know

2. The expression $(3x^2 + 5x - 12) - 2(x^2 + 4x + 9)$ is equivalent to which of the following?
   a. $x^2 + 9x - 3$
   b. $x^2 - 3x - 30$
   c. $x^2 + 13x + 6$
   d. I don't know

3. Factor the polynomial $y^2 - 9y + 20$.
   a. $(y - 2)(y - 10)$
   b. $(y - 4)(y - 5)$
   c. $(y - 2)(y - 7)$
   d. I don't know

4. Claire bought a car in 2009 for $28,500. By 2012, the car was worth $23,700. Based on a linear model, what will the value of the car be in 2016?
   a. $17,300
   b. $22,100
   c. $18,900
   d. I don't know

5. Which of the following are the exact solutions of the equation $2x^2 - 6x + 3 = 0$?
   a. $\frac{3 \pm \sqrt{3}}{2}$
   b. $\frac{3 \pm \sqrt{2}}{4}$
   c. $\frac{2 \pm \sqrt{5}}{3}$
   d. I don't know

6. The girls' volleyball team is selling T-shirts and pennants to raise money for new uniforms. The team hopes to raise more than \$250. T-shirts cost \$10 each, and pennants cost \$4 each. Which of the following combinations of items sold would meet this goal?
   a. 18 T-shirts and 18 pennants
   b. 20 T-shirts and 12 pennants
   c. 19 T-shirts and 15 pennants
   d. I don't know

7. Simplify the following expression.

$$\left(\frac{2w^2z^5}{3y^4}\right)^3$$

   a. $\frac{8w^5z^8}{27y^7}$
   b. $\frac{2w^5z^8}{3y^7}$
   c. $\frac{8w^6z^{15}}{27y^{12}}$
   d. I don't know

8. Jill can finish a puzzle in 6 hours, while Trey can finish one in 5 hours. How long would it take them to finish a puzzle together? Round to the nearest tenth.
   a. about 2.4 hours
   b. about 2.5 hours
   c. about 2.7 hours
   d. I don't know

9. Which ordered pair is the solution of the following system of linear equations?

$$\begin{cases} 3x - 8y = -50 \\ 3x - 5y = -38 \end{cases}$$

   a. $(4,10)$
   b. $(-6,4)$
   c. $(4,9)$
   d. I don't know

10. Which of the following is a zero of $x^2 + 6x - 112$?
   a. 6
   b. -8
   c. -14
   d. I don't know