2021

Winning Paper: Effectiveness of Curriculum-Based Technology in Student Learning

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INF405: Research Methods in Informatics

Professor Ginger Loggins

May 11, 2020

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As technology changes and becomes more prevalent in society, there is greater push to integrate technology into classroom instruction (Nganji, 2018). One of the main focuses in education has become developing the best way to integrate the technology to support student learning of the content while building students' technology skills (Ozerbas & Erdogan, 2016). Many teachers continue to build their own lessons integrating various programs and websites as they see fit for their instruction. Textbook and curriculum developers create digital-based content to support this growing need. The effectiveness of technology in classroom instruction, such as websites, word processing, and searching the internet, has been established in many studies throughout the world (Garavaglia et al., 2012; Joshi et al., 2019; Kardanova et al., 2018; Ozerbas & Erdogan, 2016). These studies compare technology rich classrooms with the traditional classroom. I propose an experimental design be applied to the research question how effective is the integration of technology derived from a prepared curriculum in students' retention and performance compared to general websites and digital activities integrated into lesson plans? This would fill the gap in the existing research regarding the effectiveness of various types of technology in the classroom.

Effectiveness of Technology in Education

With the development of new technology and the World Wide Web, student learners now have access to a variety of resources and content. This means that teaching and instruction have to change to adapt to these learners (Nganji, 2018). In an action study, Friedman and Heafner (2008) worked with high school social studies classes to integrate online primary and secondary sources into a research project. In previous units and courses, students had used the internet to answer lower-level questions. Friedman and Heafner endeavored to empower students to use the internet for higher-level skills like analyzing primary and secondary sources. They found students were unwilling to use their provided resources at first because students found them overwhelming and confusing. Further instruction brought the realization that students didn't fully understand the underlying topic they were being asked to research. Thus, students need scaffolding on both the content's concepts and the technology. In education, a scaffold is defined as "a temporary support that is used during the initial phases of instruction and then phased out as students master knowledge and skills" (Smith & Okolo, 2010). Friedman and Heafner (2008) propose a scaffold of decreasing the amount of content in order to allow students to dive deeper and use higher-order thinking skills. Through curriculum development, teachers in this study will provide instruction in the technology alongside the math content.

Using websites in class projects can be successful. In an early elementary classroom, students used the internet to support researching and preparing projects (Joshi et al., 2019). In this study, students had their own choice on the topic to research, and computers allowed them to explore the topic on their own, with the exception of support with spelling. Joshi et al. concluded that the computers encouraged student autonomy throughout the learning process and helped create meaningful interactions in the classroom. Couse and Chen (2010) came to similar conclusions in their study on the effects of integrating tablet computers in early education (3- to 6-year-olds). They found students quickly learned how to use the tablet to represent their ideas and learning. The quality of their drawing and writing improved, student interest increased, and students became more independent with practice. However, both studies engaged a small sample size and lacked empirical data supporting student mastery and retention. In addition, students chose a topic of interest and had choice in engagement and presentation. So, the question remains if these benefits carry over to classrooms where content is mandated by standards and performance is demonstrated through state testing.

iPads were found to support mandated math instruction by providing additional practice and instruction (Hilton, 2018). The study also found student engagement and interest in math increased while using the iPads because students felt more supported and challenged with their math, and they increased their sense of ownership of math learning. In addition, the iPads provided opportunities for teachers to differentiate learning, scaffold for students who needed it, and provide for individual learning. At the same time, even Hilton notes that this study lacks empirical data to support its findings; the study was qualitative in nature.

Digital game-based learning in mathematics also enhances the learning and knowledge acquisition for students (Hwa, 2018). In an experimental design, Hwa compared the integration of DigiGEMs, a game-based program for primary students (grades 1-3) to practice mathematical thinking skills, with traditional lessons that added paper-based games. Both classes kept the same pacing and taught the same standards. The class that used DigiGEMs showed more significant growth and retention of facts and skills as demonstrated via testing than the traditional classroom. Another digital game-based experiment with GameBoy™ *Skills Arena* showed similar growth and retention for students who practiced with *Skills Arena* versus those who practiced with paper-based games (Shin et al., 2012). In addition, those who had some practice with *Skills Arena* and some paper-based show less growth than those exclusively playing *Skills Arena*. It is important to note that both of these studies consisted of a small sample size.

Another technological innovation being integrated into classroom is the Flipped Classroom Model (FCM). According to Kostaris et al. (2017), "The Flipped Classroom Model (FCM)…[consists of] lectures [that] can be substituted with appropriately designed and/or selected learning materials…which can be provided to the students for prior 'home study'…Classroom-based time can be directed at student-engaging learning activities" (p. 262). In a study comparing classrooms teaching the same content in a traditional way with classrooms following the Flipped Classroom Model, Kostaris et al. found that FCM allowed more classroom time for collaborative and hands-on learning activities. Students were more engaged and motivated, and FCM improved the learning experiences for low-performing students. One-to-one computing initiatives, when "students and teachers have access to a personal computing device…for academic learning" (p. 967), were found to have similar results with increased student engagement as the technology brought a shift toward student-centered learning and supported self-directed learning (Varier et al., 2017). Clearly, integrating technology has some positive effects including increasing student engagement, increasing student independence, and shifting towards student-centered learning.

The question remains what effect technology has on student performance, particularly in test scores. A Russian study on first graders concluded there was no correlation between growth in the first graders' test scores over the course of a school year and how much teachers used the new interactive whiteboards and teaching aids provided in instruction (Kardanova et al., 2018). It is important to note that most teachers used the interactive whiteboards for direct instruction rather than student-directed activities. In other words, students were not directly interacting with the boards. In addition, many teachers felt they did not get enough training on the new technologies and were reluctant to use them. Kardanova et al. suggest a longitudinal study with additional teacher training in order to confirm or refute the results. Falck et al. (2018) came to a similar conclusion that using computers to practice skills provided little effect in standardized testing. However, when computers were used to lookup ideas and information, this did improve student achievement. Falck et al. declare that computer use should not replace instructional activities that would build these skills but also note that these correlations only pertain to the 4th grade and 8th grade math and science scores they were able to analyze. In addition, this study was a correlation of the scores based on surveys received from teachers about computer use; it was not a controlled experimental design and does not note the types of technologies used in the classrooms, the frequency of use, or the instructional strategies employed.

Two studies employing experimental design did see an increase in students' post-test scores for students participating in the digital classroom or blending learning model (Ozerbas & Erdogan, 2016; Hill et al., 2017). The digital classroom consisted of a computer for each student, an interactive whiteboard, and a copier/scanner (Ozerbas & Erdogan, 2016). In addition, a website was created to post class notes and assignments and allow students to communicate with each other outside of class. The focus in this study was on math, particularly circles and attributes of circles in a 7th grade unit. The control group used no technology in their lessons; there was a meaningful increase in scores for the digital classroom. Blended learning is a hybrid of teacher instruction and digital instruction allowing students to learn both from an instructor in-person and asynchronously with technology (Hill et al., 2017). Mid-term scores compared between classes utilizing blended learning and those not using it suggest that an online learning system complemented the in-class instruction and netted more successful students. This body of research demonstrates that integrated technology supports student success versus no technology. However, there is a lack of research comparing various technologies with each other in classroom instruction. Thus, I propose an experimental design study to specifically compare two technologies in the classroom: teacher found websites and resources compared with curriculum provided technologies.

Methodology

The effect of the independent variable, integration of solely curriculum-based digital components, will be measured by the dependent variable, the students' demonstration of mastery and retention of the standards, through the growth of scores between the pretest and posttest of each grade-level's units. The population of one elementary school (kindergarten – 5th grade) in the district will be divided into two groups: treatment and control. The elementary school chosen will be representative of the district: middle income, average test scores, typical attendance rates, average school size. Classes from each grade level will be selected for each group ensuring similar demographics for the treatment and control groups at each grade level: ages, grades, test scores, gender, class size, and special services. Both groups will contain an equal number of classes and students from each grade level.

Each grade level will teach a unit from the standards strand "Operations & Algebraic Thinking" which pertains to the following:

- Kindergarten – basic addition and subtraction up to 10
- 1st grade – adding and subtracting within 20 including being able to represent equations and understand the relationship between addition and subtraction
- 2nd grade – mentally adding and subtracting within 20; using equal groups to begin to understand multiplication
- 3rd grade – basic single-digit multiplication and division within 100
- 4th grade – using the four operations (adding, subtracting, multiplying and dividing) to solve problems; adding and subtracting up to 3-digit numbers; multiplying and dividing 1- and 2-digit numbers
- 5th grade - using the four operations (adding, subtracting, multiplying and dividing) to solve problems; adding and subtracting up to 4-digit numbers; multiplying and dividing 1-, 2-, and 3-digit numbers; interpreting numerical expressions

The school district already uses the math curriculum Go Math® for grades K-8. Go Math® has a built-in digital platform, Think Central, through which students and teachers can access the online textbooks, interactive whiteboard lessons, digital games, and other resources for printing. In addition, homework, class assignments, quizzes, and tests are available through Personal Math Trainer® on the Think Central platform. Personal Math Trainer® also gathers data on student's performance to build adaptive assignments at the teacher's discretion. For the scope of this study, the adaptive assignments will not be used in the unit of instruction. The treatment group will solely utilize these online resources with the textbook. The control group will use the Go Math® print materials as its foundational curriculum and use the internet and other available technology to integrate digital components.

To ensure both groups of students receive similar instruction in regards to student-teacher and student-student interaction along with technology integration, both groups will engage in a period of training and curriculum development. A few studies showed the importance of teacher training in successful technology integration (Garavaglia et al., 2012; Hilton, 2018; Kardanova et al., 2018). Thus, both groups will review the pedagogy and structure of Go Math® lessons to ensure they are teaching the same content in a similar way. The treatment group will continue training to learn the Think Central platform and Personal Math Trainer®. The control group will research and collect various websites and technology-based activities (Excel®, Google Sheets, software for fact mastery, etc.). Both groups will then collaborate to plan the lessons and chapters for their corresponding unit ensuring both the treatment and control group have similar student engagement, technology integration, and formative assessments. In addition, a lesson will be set aside for instructing students on how to use the technology and/or platform. This will allow the opportunity for teachers to scaffold the understanding of the technology and skills (Friedman & Heafner, 2008; Su & Chen, 2009).

Both groups will begin the unit by pretesting student knowledge of the standards related to the unit. The test will be created in Think Central using Personal Math Trainer®. To ensure content validity, the base of the test will be one provided by the curriculum with additional questions added from the textbook's question bank. Since both groups are teaching from the curriculum, this will ensure the test follows the content from the curriculum. In addition, internal reliability will be ensured by including multiple questions on the same test. Then, split-half reliability can be computed with the single test. The test will consist of multiple choice, fill-in-the-blank, matching, drag-and-drop, and multiple answer; it is automatically graded by the platform, so data can quickly be compared between classes and across standards.

Each group will teach the unit using the lesson plans created during their collaborative curriculum planning. To ensure fidelity, researchers will observe each class at least twice during the unit, using the lesson plan as a checklist. Also, teachers will keep a short reflection of each lesson, marking what was completed and making observations of student work. Finally, daily formative assessments of the lesson will support what students learned.

The unit will end with a posttest. Because Personal Math Trainer® provides 5 different variations of each question, the same test can be used for the pretest and posttest. Personal Math Trainer® will automatically provide a different variation for each student. Content validity and internal reliability will remain the same as the pretest.

This data will be analyzed multiple ways. Student growth between the pretest and posttest will be compared between both the treatment and control group. In addition, the overall performance of each group on the posttest will be compared as well. Additional comparisons and analyses can be made between gender in each group, special services, and specific standards covered within the unit.

Discussion

The purpose of this study is to compare the effectiveness of textbook-based technologies with teacher found websites and technologies. In order to establish curriculum-based digital components as the cause for the increase in students' scores, I chose an experimental design for this study. Also, this study could be replicated in other districts and schools using Go Math® or another curriculum with built-in digital components. The hope is to replicate this in a middle school in the same district along with other populations, such as urban-setting and gifted and talented schools. Because one average school is a small sample of a large school district's population, it is difficult to generalize the results across all elementary schools. The smaller sample was chosen for simpler logistics. The professional development, curriculum development, and observations require time and man power. Thus, further research is needed in other grade levels and student populations.

It is recognized that it is difficult to control all variables in this study. Classes will be taught by different teachers. Even with training and curriculum development, different personalities and teaching styles will still remain. Accountability with observations, reflections and formative assessments will support fidelity. Replication is recommended to ensure similar results and conclusions. In addition, the student population cannot be controlled; some students will have experience with technology and this curriculum while others do not. This could influence student performance initially. Lessons on the technology and scaffolding will help all students improve over time.

Standards across the grade levels were chosen from the same strand, “Operations & Algebraic Thinking,” to help ensure similar content being taught. Having one grade level teaching Geometry while another taught Number Sense could potentially add an additional variable or consideration for differences in scores. Rather, the standards chosen build on each as grade levels increase.

Since teachers are collaborating and developing the curriculum together, the goal is to ensure an equal utilization of technology in both the treatment and control groups. Although the types of digital resources utilized will vary between the two groups, the amount of time students have access to technology should not vary.

This study is important in establishing the usefulness and significance of curriculum-based digital components. Many teachers and districts obtain new curriculum but continue to use teacher-built and found resources rather than utilizing the curriculum-based materials. For some teachers, it is a matter of comfort-level and lack of understanding of the components (Garavaglia et al., 2012; Hilton, 2018; Kardanova et al., 2018). Teachers know what they have always used, so they continue to use it with the new curriculum. Other teachers have integrated components but feel from anecdotal observations or failure of student engagement that the components are insufficient for obtaining student mastery. With increased standards and testing along with technological requirements for instruction, teachers need digital instructional resources proven to work. This study endeavors to provide such evidence.

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