Technology and achievement in first-grade math: A comparison study

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Introduction

Technology has become a necessity rather than a luxury in today's world. The issue was a platform during the 2000 United States presidential election, and Title I money has been used to provide further technological devices within the school systems, whether it be for identified learning disabled students or regular classrooms. As our children become evermore enveloped in a globally interdependent society, it is important to examine the educational settings in which they are learning and interacting with one another, particularly their use of technology. The desire to see benefits to technology in education likely stems from businesses seeing profit, as there is no proof supporting the idea that spending money to improve technology in schools and to provide Internet access improves student achievement (Trotter, 2002b).

The National Council of Teachers of Mathematics sets standards for different groups of learners in the content area of math. From preschool age through the second grade, the organization recommends that learning should take place in an environment that is rich in language, encourages thinking, values uniqueness, and supports exploration. The organization also sets standards for using technology, stating that computers contribute to student learning by providing immediate feedback and allowing students to make connections between different representations (http://standards.nctm.org, 2000). Students are using technology at a continuously younger age and it is an integral part of their surrounding world (Craig, 2000). A study conducted by Creative & Response Research Services in August 2002 found that 65% of children between the ages of 2 and 17 use the Internet (Trotter, 2003a). However, the majority of studies have focused on how technology affects achievement of older students. Researchers have undertaken an attempt to prove that utilizing technology in classrooms does positively affect student achievement (Middleton & Murray, 1999; Cramer & Smith, 2002).

Middleton & Murray (1999), in their study, attempt to examine the relationship between a teacher's implementation of technology within the classroom and achievement scores on standardized tests in reading and mathematics. Using the Levels of Technology Implementation (LoTi) measure (Moersch, 1994), 107 teachers in a large South Carolina school district were asked to enter both demographic information about their class and information about how often they used technology in their instruction. Additional questions also inquired about what type of technology was employed, teachers' inferences about technology's effects on student achievement, discipline, etc. and how much the teachers believed the implementation of technology improved their instruction.

Using the Metropolitan Achievement Test, fourth and fifth graders were assessed for achievement scores in mathematics and reading. 1466 fourth graders and 1108 fifth graders were tested for a total of 2574 students. One-way ANOVA variance procedures were used to analyze the results for significant differences.

The researchers found the fifth grade teachers utilized technology much more than the fourth grade teachers in their instruction, and test results correlated positively to this usage. Significant differences were found in the scores for math and reading among fifth graders. However, no significant differences were found among the fourth graders, whose teachers used much less technology within their curriculum.

Accordingly, Middleton & Murray concluded that the cost of implementing technology into the classroom was beneficial to students and their levels of achievement.

A second study focused on students' writing abilities and how technology inserted into a language arts curriculum impacted writing scores. Cramer & Smith (2002) investigated how two different writing curriculums affected writing abilities of middle school students over the course of an academic year. Two middle schools were used in the study, with a total of seven classrooms. One school and four of its classrooms utilized traditional methods of instruction, including assigned essays, journal writing, and teaching spelling and grammar. The second school, with three classrooms, used a technology-enriched curriculum, considered the "Movie Project." The "Movie Project" allowed students, in teams, to develop movie scripts and produce one selected by the class. Other forms of technology were utilized in projects throughout the course of the academic year in this particular school.

Twenty percent of all students were randomly selected to participate in the study, though all students participated in the instruction and assessment measures in the classroom. Writing samples were collected at the beginning of the year from students, with teachers assigning their students independently of one another. At the end of the academic year, after the curriculum was completed, another writing sample was collected and scored. All writing samples were scored according to three criteria, each marked on a 5-point scale: ideas, organization, and voice. Teacher interviews were also conducted to determine how often technology was inserted into the curriculum.

The researchers discovered that there were differences in the writing abilities between the two schools at the beginning of the school year, but these differences leveled out at the end of the year. However, no conclusive evidence was found to support the theory that technology infused into curriculum advances student learning any more so than traditional means of instruction.

Since children are students of the twenty-first century and are utilizing technology at a much younger age, it should be investigated as to how implementing technology into classrooms for young students impacts their achievement. Software that is developed for young learners can help students understand math concepts much more clearly and also build skills necessary for internalizing learning (Craig, 2000).

In this proposal, the study is intended to quantitatively determine how much technology influences the achievement of first-grade students in the content area of mathematics, particularly the learning of addition facts. The research will focus on how three different methods of instruction (traditional methods, computer-assisted feedback, and computer games) compare to one another in terms of teaching first-graders simple addition, and also how each type of instruction affects a student's self-efficacy.

It is anticipated that students in the group receiving traditional methods of instruction will attain higher achievement scores than students in either of the computer groups. Students participating in the computer-assisted feedback group should also score higher on the achievement assessments than students in the computer-game group. The game will have students focusing on obtaining the correct answers merely to complete the mission, compared to students in the computer-assisted feedback group, who will have increased focus on learning the addition facts in order to continually obtain the correct answer and positive feedback.

In terms of self-efficacy, it is expected that students in the computer-game group will have the highest levels of self-efficacy and enjoy mathematics the most, with the students in the traditional method of instruction following, and the students in the computer-assisted feedback group having the lowest self-efficacy levels. These results are expected because computer feedback is simple and direct, and cannot be modified with tone or expressions a teacher can provide to students. The computer-game group is expected to surpass the computer-assisted feedback group because the game is more enjoyable to students.

Methodology

Thirty first-grade teachers in seven different schools within one school district and their students will participate in the experiment (n=679 students). The classrooms are comparable to one another and representative of the general population in terms of socioeconomic status and academic ability. Dependent variables in the study will be self-efficacy levels and achievement scores. The independent variable to be manipulated is the form of instruction received for the addition process unit.

Kindergarten records will be checked to ascertain the students' abilities in math/numerical identification. It will be ensured that each class has a similar disparity of ability levels. The structure of the study predetermines that if there is a large difference in abilities, students who contribute to the large deviations in ability among classrooms will not be included within the sample. However, to maintain classroom environments, they will participate in the instruction as well as the achievement and efficacy assessments.

The students' kindergarten records will also be screened for their spatial abilities. Any students deemed to have insufficient spatial abilities would be placed into the traditional method of instruction group in their respective classroom to avoid running into time constraints within the classroom and to avoid interference with the student's self-efficacy and math achievement.

Students will be taught the addition process for one week, using traditional worksheets and other methods of practice and teacher-constructed feedback, to insure that each child knows how to apply the addition process. The students will then be divided into their instruction groups for the following two weeks of math instruction. All students will receive their respective methods of instruction simultaneously.

Students receiving a traditional method of instruction will continue to be taught by their teacher, using techniques such as flash cards, worksheet drills, and teacher-to-student feedback. Students participating in the two computer methods of instruction will be given an hour of initial playtime on the computer to ensure each child knows how to use a mouse and keyboard. Any students who seem unsure of what they are doing will be shown by the teacher how to use the machine. (Researchers will remain as observer-participants throughout the experiment, with the exception of the self-efficacy interviews.)

Following this, students who are in the computer-assisted feedback group will be placed on computers installed with the *Grade 1 Math* program (School Zone Publishing). The program has been determined to be of high educational value (4.5 on a 5.0 scale) by the educational software review web site, www.superkids.com, and also to be of high appeal to young children (4.5 on a 5.0 scale). The program allows for continuous practice of addition problems, with continuous feedback. As the student moves through the program, bees surrounding the math problems will color green when the student answers correctly and red when the child answers incorrectly.

Students in the computer-game group will be instructed using the computer game *M&M's: The Lost Formulas* (Simon & Schuster Interactive). The game provides a mission for the student to return the yellow and red M&M's to the M&M Factory from vacation in order to restore the formulas that the Mini M&M's have recklessly lost. Hand-eye coordination of the player will be challenged with obstacle courses, multiple directions of motion, and frequent animation. The game will not be placed in default mode (only one section with math problems to solve) to ensure the most practice with addition problems. The difficulty level of the program will be set at medium.

After the two weeks of differentiated instruction, students will return to a regular classroom set-up for one session of review with the teacher. The following day, an assessment will be given to all students. The assessment is a random compilation of addition problems using the numbers 1 through 9 created by a worksheet generator at www.superkids.com (See Appendix 1 for complete assessment and answer sheet). Fifty questions will be presented to students, and scored accordingly on a scale of 100, with each question worth two points. Questions will be either correct or incorrect, with no allowances for unclear answers.

Subsequent to the assessment, researchers will assume participant status and qualitatively interview the students to determine their self-efficacy levels with regards to the content area of mathematics. Students will be asked five open-ended questions concerning the method of instruction they received, such as: how did you feel when the teacher/computer told you that you were wrong, do you like math, do you feel smart in math? (See Appendix 2 for complete list of questions.)

Data Analysis

Data for the achievement scores will be analyzed using a one-way ANOVA. The means of each group's scores on the assessment will be collected, and comparatively studied to determine with what method of instruction the greatest achievement occurred.

The researchers' qualitative interviews with each student will be quantitatively scored using a Likert-type scale of 1 to 5, with 1 equal to very low self-efficacy, 3 being average self-efficacy, and 5 signifying a very high level of self-efficacy. Interrater reliability will be accommodated for by taking the mean of any deviation in scoring for each student's interview. Using a second one-way ANOVA test, these scores will then be analyzed to determine where each group's standard level of self-efficacy is.

Significance of Proposed Research

With students using technology both in and out of school at such a young age, schools need to assess how technology impacts a student, cognitively and mentally. It is important to determine what effects come with implementing technology in a classroom and whether the costs equate the benefits. Though previous studies and articles (Middleton & Murray, 1999; Cramer & Smith, 2002; Craig, 2000) have attempted to discern whether technology in the classroom affects achievement in older students, this research study proposes that students are particularly vulnerable to methods of instruction when formulating their knowledge base at a young age.

This research has practical implications for everyday instructional techniques with early learners. If technological implementation within a classroom environment poses possibilities to increase student achievement at a young age, perhaps the debate for funding for technological resources can be quelled. Higher-order thinking skills can possibly be developed further if technology is used in a practical manner within classrooms, provides constructive feedback, and emphasizes learning rather than entertainment.

The results of this study should not be taken as conclusive evidence to support or refute the theory that technology in classrooms advances student learning, but rather as a step further into the investigation that different methods of instruction might affect students in a positive manner. Discovering the best format for students to actively learn material utilizing a variety of methods for instruction and providing opportunities for this type of learning to take place is essential to striving to provide students with the best education possible.

Appendix A

Self-Efficacy Interview

Mathematics Instruction & Achievement

Traditional Methods of Instruction

1. Do you think you are good at math?
2. How do you feel when the teacher tells you that you are wrong?
3. Do you think you will be good in math next year?
4. Do you feel smart in math?
5. Do you like math?

Computer-Assisted Feedback

1. Do you think you are good at math?
2. How did you feel when the bees turned red, telling you that you were wrong?
   (Did you not want to play on the computer anymore?)
3. Do you think you will be good in math next year?
4. Do you feel smart in math?
5. Do you like math?

Computer-Game Method

1. Do you think you are good at math?
2. How did you feel when you won/lost the computer game?
3. Do you think you will be good at math next year?
4. Do you feel smart in math?
5. Do you like math?

Appendix B

Name ______________________________ Date ____________________

SuperKids Math Worksheet
Addition using numbers between 0 and 9

4 + 0	9 + 5	5 + 1	4 + 3	3 + 0
3 + 2	5 + 4	6 + 1	8 + 7	2 + 1
3 + 2	3 + 0	7 + 4	1 + 0	5 + 0
3 + 1	4 + 3	2 + 0	8 + 1	4 + 1
8 + 0	6 + 4	1 + 0	3 + 1	3 + 2
1 + 0	3 + 1	4 + 0	5 + 3	4 + 3
9 + 4	3 + 0	4 + 0	8 + 6	5 + 1
9 + 7	9 + 1	9 + 6	1 + 0	3 + 2
8 + 3	1 + 0	2 + 1	2 + 0	8 + 5
2 + 1	8 + 4	5 + 1	5 + 0	9 + 7

References

Craig, D.V. (2000). Technology, math, and the early learner: Models for learning. *Early Childhood Educational Journal, 27,* 179-184.

Cramer, S. & Smith, A. (2002). Technology's impact on student writing at the middle school level. *Journal of Instructional Psychology, 29,* 3-14.

Middleton, B.M. & Murray, R.K. (1999). The impact of instructional technology on student academic achievement in reading and mathematics. *International Journal of Instructional Media, 26,* 109-116.

Moersch, C. (1995). Levels of technology implementation (LoTi): A framework for measuring classroom technology use. *Learning and Leading with Technology, 23,* 40-42.

NCTM Standards, Pre-K – 2. Retrieved June 16, 2003, from http://standards.nctm.org/document/chapter4/index.htm.

Trotter, A. (2002a). Digital dilemma: Can computers sub for teachers? [Electronic version]. *Education Week.* Retrieved April 16, 2003, from: http://www.edweek.com/ew/ew_printstory.cfm?slug=07compute.h22.

Trotter, A. (2002b). Internet access has no impact on test scores, study says [Electronic version]. *Education Week.* Retrieved April 16, 2003, from: http://www.edweek.com/ew/ew_printstory.cfm?slug=01internet.h22.