Effect of Using an Abacus as a Concrete and Virtual Manipulative in a Second Grade Classroom

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Research Proposal
Abstract

This study considers the use of an abacus as a concrete and virtual manipulative to promote mathematical performance. Two hundred ninety-one second graders from three schools in urban southeastern Virginia will participate in the year-long study. This quasi-experimental study will randomly assign 14 teachers to the experimental or control group, approximately 22 students per teacher or 150 per group. Using two different levels of the Iowa Tests of Basic Skills (ITBS) as pre and post-tests, mean scores for the two groups will be compared (Hoover et al., 2004). It is expected that students taught with the abacus will outperform the control group in terms of their ITBS scores. Potential implications would include incorporating the abacus into second grade mathematics curriculum.

*Keywords:* abacus, manipulative, mathematics
The Effect of Using an Abacus as a Concrete and Virtual Manipulative in a Second Grade Classroom Environment

Concrete manipulatives (CM) are manipulatives students can touch and change with their hands. Virtual manipulatives (VM) are computer-based manipulatives students can either use on their own or a teacher can use for classroom demonstrations.

Purpose and Justification of the Study

This study will look at whether the introduction of an abacus into the mathematics curriculum of second graders helps improve students’ mathematics knowledge base, such as number concepts, computational skills, application, and problem solving skills (Shen, 2006). Studies have explored the benefits of manipulatives and when used properly, agree manipulatives are beneficial (Moch, 2001; Shen, 2006; Steen, Brooks, & Lyon, 2006; Suh & Moyer, 2007; Tournaki, Bae, & Kerekes, 2008). A manipulative available as both a CM and VM offers different representational forms that help promote student learning (Suh, 2007).

Literature Review

Concrete and Virtual Manipulatives

Research findings for use of manipulatives are mixed (McNeil, & Jarvin, 2007). Many teachers find CMs provide visual models and help reinforce concepts they teach (Moch, 2001; Moyer, 2001). Allowing students to interact with a CM before moving on to abstract levels reduces time spent re-teaching material (Moch, 2001). Both CMs and VMs help maintain student focus during lessons and improve participation (Moch 2001; Moyer, 2001; Steen et al., 2006). A study found using a VM is more effective for first graders than the use of traditional textbook activities (Steen et al., 2006). Manipulatives serve as tools to make a connection between new and existing knowledge (Moyer, 2001).
Students with Learning Disabilities or Mental Retardation

Tournaki et al. (2008) noted students with learning disabilities are often taught to solve each problem in a specific way, which disregards informal strategies. The study found using the Rekenrek, a CM design based upon a five-structure and similar to the ten-structure abacus, helps students acquire the associative and commutative properties of addition on their own, on top of the addition skills being taught (Tournaki et al, 2008). Shen (2006) found students with mental retardation benefit from mental abacus training, when the abacus is first used as a CM followed by mental images of an abacus, so students progress from concrete, to semi-concrete, and finally to the abstract process. Studies show the use of an abacus by students with mental retardation, or similar CMs by students with learning disabilities, has been beneficial.

Research Question, Hypothesis, and Definitions

Research question. Will second grade students benefit from using the abacus as both a CM and VM?

Hypothesis. Second graders taught mathematics skills using an abacus will perform better in mathematics than those not exposed to instruction using the abacus.

Definitions. Second graders’ mathematics knowledge base can be measured by the Math Concepts, Problems, and Computation sections of the Iowa Tests of Basic Skills (ITBS) (Hoover et al., 2004).

Methods

Participants

Two hundred ninety-one second graders from three public elementary schools in urban southeastern Virginia will participate in our study. School A has 655 students, 51% are Black, 26% White, 14% Hispanic, 4% Asian, and 5% unspecified; 48% are female (Virginia DOE,
School B has 710 students, 46% are Black, 36% White, 9% Hispanic, 4% Asian; and 5% unspecified; 46% are female (Virginia DOE, 2009). School C has 494 students, 63% are Black, 16% White, 12% Hispanic, 4% Asian; and 5% unspecified; 51% are female (Virginia DOE, 2009). For free or reduced lunches, 46.88% from School A, 33.79% from School B, and 77.04% from School C are eligible (Virginia DOE, 2003). Each school has made Annual Yearly Progress for the last three years (Virginia DOE, 2010).

The school district community’s population is estimated at 193,172, of which 47.9% are White, 42.5% Black, 5.3% Hispanic, and 2.7% Asian; the national population consists of 65.6% White, 12.8% Black, 15.4% Hispanic, and 4.5% Asian (US Census Bureau, 2000). The per capita personal income for this school district is $30,752, while the national average is $40,166 (Bureau of Economic Analysis, 2008). Eighty-five percent of residents over the age of 25 possess a high school diploma, 20% possess a bachelor’s degree or higher, while the national averages are 80% and 24% respectively (US Census Bureau, 2000).

All second graders with permission will participate in the study. Of the 14 classrooms, seven will be randomly assigned to the experimental group and seven to the control group.

**External Validity**

This district’s population has a lower personal income, resulting in higher eligibility for free and reduced lunches, though educational levels are comparable to national averages. These schools have a higher percentage of Black students than both city and national percentages. Results will be generalizable to school districts with low incomes, average education, and a high percentage of Black students.

**Instrument**
The ITBS is norm referenced achievement test reporting percentiles, with levels corresponding to target ages and grade levels (Hoover, et al., 2004). Level seven and eight subtests assigned to second graders from the ITBS measure growth in fundamental areas of school achievement including Math Concepts, Math Problems, and Math Computation (Hoover et al., 2004). Internal consistency reliability varies from .80 to .90 dependent upon grade tested (Hoover et al., 2004). The 30 minute math section of the ITBS assesses a range of student skills, including higher level thinking, multiple-stepped problem solving, and the identification of insufficient information (Hoover et al., 2004).

**Design and Procedures**

This study will be a quasi-experimental nonequivalent comparison-group design using pre- and post-tests. Classrooms will be designated as experimental or control through random assignment of each teacher. Researchers will administer the ITBS-7 to participants in the fall. Throughout the year, teachers in experimental classrooms will utilize the abacus anytime addition or subtraction is taught. Initially, the abacus will be used as a CM with students manipulating its beads. Later, the abacus will be present as a visual reference but will not be manipulated. Finally, students will be prompted to employ a mental image of an abacus when completing work. Throughout the year, students will be encouraged to use a virtual abacus at school or when completing mathematics homework. The ITBS-8 will be administered at the end of the school year.

**Timeline**

- **January**: apply to IRB
- **Early July**: randomly assign teachers to experimental or control group
- **Mid-July**: teacher training
• Mid-August: gather permission from participants’ parents
• Early September: administer pre-test (ITBS-7)
• September-May: implementation of abacus into mathematics curriculum
• Late May: administer post-test (ITBS-8)
• June: data analysis
• July: results and conclusion writing

Internal Validity

Participant characteristics. Differences in gender, cultural background, SES, previous location of schooling, and military status could become confounding variables. Collecting basic information about these variables for analysis will reduce this threat.

Mortality. High military presence could lead to excessive loss of participants. Participants attending three schools, none of which serve military children exclusively, should help control for such loss.

Implementation. Differences in abacus instruction between teachers could threaten internal validity. Besides initial training, researchers will observe classrooms periodically and provide review for teachers as needed.

Data Analysis

Data from the experimental classrooms will be combined and compared with data from control classrooms. Changes in mean scores on the ITBS for the two groups will be compared to determine whether the experimental group scores experienced a larger change due to implementation of the abacus.

Expected Results
It is expected that the mean gain on the ITBS will be significantly higher for the group instructed with the abacus than the group which did not receive such instruction.

Discussion

Conclusions

Results will indicate that using an abacus as a CM and VM increases students’ mathematical performance because of the continuity between the CM and VM aspects of the abacus.

Implications

Schools should incorporate the abacus into their mathematics curriculum.

Budget

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References


Tournaki, N., Seh Bae, Y. Kerekes, J. (2008), Rekenrek: A manipulative used to teach addition and subtraction to students with learning disabilities. Learning disabilities: A contemporary journal, 6(2), 41-59.

