Mathematics Play, Problem Solving, and Perseverance

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Abstract

The research presented in this article focuses on the effect of student use of problem solving apps on a tablet PC either prior to (motivation) or immediately after (reward) a classroom assessment. The classroom teacher developed the assessment. Continued practice throughout the school year is measured by collecting data on benchmark testing completed by fifth-grade students in the fall, winter, and spring administrations.

The team of the researcher and classroom teacher wanted to study the effect of using tablet computers in the fourth and fifth grade classrooms. Specifically, they wanted the answer to "Does using problem solving apps either as a motivator or reward help students perform differently on classroom assessments and high-stakes tests?" This is an important question to answer for student development and the yearly evaluation of the classroom teacher.

The two variable groups for the analysis includes the Pretest scaled score and the Posttest scaled score. The purpose of this analysis was to determine if using the problem solving apps helped the students throughout the year with the three administrations of the benchmark testing. Scores for the fall administration represent the Pretest score (PreScale) and the Posttest score (PostScale) were gathered using the spring administration.

Descriptive statistics on the two variables show that the posttest score has a much larger standard deviation. However, the difference does not show it as statistically significantly different. The paired t-test showed a calculated test statistic value of 0.000. The use of p=0.05 indicates a rejection of the null hypothesis.

The paired sample correlation values concurred with a statistically significantly difference. The correlation value of 0.691 indicates a significance of probability at 0.000. Since the variable change is a positive correlation value, then it is a direct correlation.. The correlation value indicates a strong relationship between the variables.

Keywords: mathematics education; motivation; reward; teacher evaluation; instructional technology

1. Introduction

The National Council of Teachers of Mathematics (NCTM) documented the use of problem solving in the K – 12 curricula since 2000 (Hoosain & Chance, 2004). Problem solving includes "engaging in a task for which the solution method is not known in advance" (NCTM, 2000, p. 52). Students enrolled in fourth and fifth grade used problem solving applications (apps) available for a tablet in iOS and Android in a mathematics class. The intention was for the apps to help the students use problem solving in mathematics to acquire ways of thinking, habits, persistence, curiosity, and confidence in unfamiliar situations (NCTM, 2000). Continuing, “problem solving is not a distinct topic but a process that should permeate the entire program and provide the context in which concepts and skills can be learned” (NCTM, 2000, p. 23). The classroom teacher continuously uses problem solving as a teaching method to keep instruction student-centered with a focus on inquiry.

The use of problem solving in the research project involved students using tablet apps before or after completing a classroom mathematics assessment. The researcher and classroom teacher agreed that this use of tablets would be motivating for the students. In addition, this setting could be compelling to the students. In addition, it can provide the necessary motivation for persistence to complete mathematics problems until the students find a reasonable solution.

2. Background

Problem solving is an example of Cognitive Guided Instruction (CGI). The problem solving approach to CGI includes students using physical, pictorial, or symbolic algorithms to share their work with classmates (Hoosain & Chance, 2004). In addition, students are given ample opportunity for free play and for sharing their creations (van Hiele, 1999). Also, the CGI approach easily addresses NCTM’s Process Standards of Problem Solving, Reasoning and Proof, Communication, Connections, and Representation; this is one of standards’ greatest benefits. More important, learners become adept at these processes (Hoosain & Chance, 2004, p. 474). This allows teachers to view misunderstandings when teaching arithmetic. Finally, CGI methods allow teachers to focus on the differentiation of teaching and learning helps to address this problem by respecting the different levels that exist in the classroom, and by responding to the needs of each learner (Konstantinou-Katzi, Tsolaki, Meletiou-Mavarotheris & Koutselini, 2013)

Problem solving is essential to mathematics learning. NCTM (2000) defines problem solving as “ it means engaging in a task for which the solution method is not known in advance” (p. 52). This process allows for student inquiry in the mathematics classroom. The problem solving approach counters dominant cultural beliefs about the teaching and learning of mathematics Many people (i.e.: parents and some teachers) believe that memorizing facts and procedures is the essence of teaching and learning mathematics will provide students a sufficient mathematics education. This view is far from the truth. (NCTM, 2014).

Students should develop ways of thinking, persistence, and confidence by becoming a good problem solver (NCTM, 2000). These skills will help students in daily skills outside the classroom. In particular, when teachers focus on problem solving as an integral part of all mathematics learning, it no longer is an isolated part of the mathematics program (NCTM, 2000). A current view of mathematics teaching methods includes, “Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies” (NCTM, 2014, p. 10)

Difficulties can arise when a person's analytical skills are diminished by various types of errors made in the problem solving process. Whimbey and Lochhead (1986) describe four types of breakdowns as 1) Person fails to observe and use all of the relevant fact of a problem. 2) Person fails to approach the problem in a systematic step-by-step manner, making leaps in logic and jumping to conclusions without checking them. 3) Person fails to spell out relationships fully. 4) Person is sloppy and inaccurate in collecting information and carrying out mental activities (p. 11).

Errors can affect learning mathematics content as related to the NCTM (2000) views on using problem solving when teaching mathematics. These views are supported by Van de Walle, Karp, and Bay-Williams (2016) with their focus on teaching mathematics 1) For problem solving, 2) About problem solving, or 3) Through problem solving. These views provide teachers the opportunity to use problem solving in ways that best meet the needs of their students to understand mathematics. In addition, the NCTM problem solving process standard.

3. Theoretical Framework

Piaget remains as one of the most renowned cognitive development theorists. He "recognized distinct differences in children's and adolescents' responses to question that directly correlated to their chronological ages" (Powell, 2015, p. 40). This information along with Vygotsky's Zone of Proximal Development provides the theoretical framework for the ensuing research. Vygotsky also "believed that children's learning is shaped by the culture and society around them" (Powell, 2015, p. 40). The culture for learning focused on using tablet technology as a motivator or reward in the classroom.

4. Statement of the Problem

In the United States, high stakes testing is used in every state to some extent. Students in grades four and five are assessed annually in mathematics among other content areas (LA Department of Education, www.louisianabelieves.com). In addition, Louisiana public schools uses PARCC (Partnership for Assessment of Readiness for College and Careers) assessments. "PARCC is a group of states working together to develop high-quality assessments" (LEAP Assessment Guide, 2016, p. 1).The population of students considered for this research completed benchmark testing throughout the 2014 – 2015 school year. Many students have had problems in the past focusing on the test throughout the duration of the test. The focus general mathematics Louisiana goals for grades three through eight includes

1) A focus strongly on the content most needed in each grade while reflecting the expectations of the rigor detailed in the content standards,

2) An address on the conceptual understanding, procedural skills and fluency, and application in every grade and at each performance level (unsatisfactory, approaching basic, basic, proficient, and advanced,

3) A meaningfully connection between mathematical practices and processes with mathematical content, and

4) Completion of performance tasks that ask students to model and make mathematical argument. (LADOE, www.louisianabelieves.com).

The fourth grade students completed the Louisiana Educational Assessment Program (LEAP test) in spring 2015 with the fifth grade students completing benchmark testing in spring 2015.

5. Research Question

The team of the researcher and classroom teacher wanted to study the effect of using tablet computers in the fourth and fifth grade classrooms. Specifically, they wanted the answer to "Does using problem solving apps either as a motivator or reward help students perform differently on classroom assessments and high-stakes tests?" This is an important question to answer for student development and the yearly evaluation of the classroom teacher.

5.1 Research Project Description

The research project used play to either reward or motivate fifth-grade students when used with a classroom assessment. The research pilot involved dividing the students into two groups. One group completed problem-solving applications on a computer tablet before an assessment with the other group after the assessment.

The focus of the research was the completion of problem solving activities with technology as the medium. The technology included using iPad mini units with problem solving apps. None of the apps focused on mathematics content. Although the fourth and fifth grade students have the same teacher and used the iPad apps, data were collected and analyzed for the fifth grade students.

5.2 Rationale for the Study

Students are not easily intrinsically motivated to perform their best on all classroom assessments and on standardized tests. The intent of the research was to determine if using problem solving skills in a technology environment would help student performance on high-stake tests.

In a study completed by Johnson (2013), results indicated that an enhanced student motivation was the most frequently reported benefit of using tablet computers in school followed by instructional planning advantages. The focus on student motivation should help student persist with item completion on assessments.

6. Design

Students were assigned to groups to use the iPad apps either before or after assessments. The research is to infer for other grade levels and future school years if using technology before (motivation) or after (reward) affects student performance on assessments. The classroom teacher collected the data for use of iPads (before or after assessment), pretest scores, posttest scores and benchmark scores. The 2014-2015 year was a pilot year and did not include using a control group. The researchers will implement using a control group after they develop a stable use of variable grouping.

The research project took the use of play to either reward or motivate fifth-grade students when used with a classroom assessment. The research pilot involved dividing the students into two groups. One group completed problem-solving applications on a computer tablet before an assessment with the other group after the assessment. The focus of the research was the completion of problem solving activities with technology as the medium. The technology included using iPad mini units, SmartBoards, and geometry manipulatives. The applications included, but were not limited to, one where students made a path for a marble to travel; another creating trains with a specified path or having to change colors then finish its path to a depot.

The data gathered included the grouping variable of using the problem solving apps before and after the classroom assessments, and state benchmark testing scores as a scaled score (ratio data variable) and as a level score (ordinal data variable). The analyses included a paired t-test with the pretest and posttest benchmark scaled scores and correlation with the same variables.

6.1 Variables

- Independent - iPad usage (Nominal data for before or after assessment)
- Dependent - Benchmark test score (Scaled, ratio data) or
- Benchmark test score (Level, ordinal data)

The Louisiana Department of Education contracted Discovery Education to develop a benchmark test that links classroom instruction to the state's PARCC high stakes test. Benchmark tests are administered in the fall, winter, and spring during an academic year.

7. Setting and Participants

The population included all fourth and fifth grade students attending a university laboratory school. The school is a public school associated with a local school district although students pay tuition to offset costs that are not paid for by the state. The school has a Child Development Center for pre-school age students. The school is categorized as elementary and begins with Kindergarten and ends with grade 5. There are two classes for each grade level along with teachers for art, music, physical education, and library. Each class has approximately 25 students each academic year. In addition, resource teachers for special education, adapted physical education, and academically gifted provide daily services to students.

7.1 Data Collection

The pre-existing data were collected upon approval by the university's Institutional Review Board (IRB) committee. A second IRB approval by the public school system was not necessary as students and parents sign forms agreeing to their test scores used as data for research. The information gathered on each participant included the benchmark test score by scaled score (ratio measurement scale) and level score (ordinal measurement scale). The iPad usage of before or after was indicated by a nominal measurement scale (Wiersma & Jurs, 2009).

7.2 Treatment of the Data

Student anonymity is assured through using random number identifiers for each student. In addition, confidentiality is maintained through keeping the data in a secure off-site location. The researcher and classroom teacher maintain confidentiality by not discussing subjects by name at any time particularly in the school setting.

8. Data Analysis

Output summary resulted from using the data in SPSS Statistical Software for each variable used in the different relationships. One such analysis was a paired t-test using the Pretest scaled score with the posttest scaled score. The same analysis was completed using the Pretest and posttest scores in the levels (1, 2, 3 or 4) used by the Louisiana State Department of education.

8.1 t-Test

This inferential statistics test is useful when comparing scores or values from two groups (Lochmiller & Lester, 2017). The two variable groups for the analysis includes the Pretest scaled score and the Posttest scaled score. The purpose of this analysis was to determine if using the problem solving apps helped the students throughout the year with the three administrations of the benchmark testing. Scores for the fall administration represent the Pretest score (PreScale) and the Posttest score (PostScale) were gathered using the spring administration.

Descriptive statistics on the two variables show that the posttest score has a much larger standard deviation. However, the difference does not show it as statistically significantly different. The paired t-test showed a calculated test statistic value of 0.000. The use of p=0.05 indicates a rejection of the null hypothesis.

8.1.1 Summary Tables

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
PreScale	1522.02	56	47.207	6.308
PostScale	1680.23	56	99.853	13.343

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper			
PreScale - PostScale	-158.214	75.422	10.079	-178.412	-138.016	-15.698	55	.000

The paired sample correlation values concurred with a statistically significantly difference. The correlation value of 0.691 indicates a significance of probability at 0.000. Since the variable change is a positive correlation value, then it is a direct correlation (Salkind, 2014). The correlation value indicates a strong relationship between the variables.

Paired Samples Correlations

	N	Correlation	Sig.
PreScale & PostScale	56	.691	.000

9. Implications in Future Research

The research team found it difficult to include a control group for true experimental design as it would have been difficult for fourth graders to understand that they would not "play" with iPad mini units like remaining members of the class. It is possible that the research design will include a control group in future years. This would change the design from quasi-experimental research to a research design.

The classroom teacher indicated that having some students complete the problem solving apps before the test and others afterward made record keeping difficult. In future school years, students will be assigned the tablet usage before or after the assessment by entire class. However, this will only provide meaningful statistics if the ability levels of the individual classes are similar.

5. Conclusion

The research completed demonstrates that students completing the tablets have an influence when comparing pretest and posttest benchmark scores. Students were eager to complete mathematics work on days that they used the iPad apps. This research leads to an investigation of the effect of further problem solving apps as a predictor of high-stakes testing scores.

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