INTERACTIVE LEARNING GAMES can significantly improve EARLY MATH LEARNING and opportunities for CROSS-GRADE GROWTH

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Abstract

This study set out to determine the effectiveness of interactive learning games on the development of math learning in young children. The 89 Kindergarten students in an Ontario, Canada school district taking part in the study were split into treatment and control groups. All students were assessed at the beginning and end of the study. Teachers in the treatment group used an interactive learning game called *Zorbit's Math Adventure* for a minimum of three 20-minute sessions over an 8-week period. Analysis of the results showed that students in the treatment group (those who used Zorbit) saw statistically significantly more growth than the control group — roughly the equivalent of one year's natural growth. The study suggests interactive learning games like *Zorbit's Math Adventure* may be an important part of a teacher's toolbox for Kindergarten math instruction.

Introduction

Researchers continue to find evidence of the ways in which technology can be used to impact teaching and learning positively.[i] For instance, educators have shared evidence that innovations like digital games can be used for content-area acquisition in literacy[ii], science[iii], and math[iv]. It is critical to note, however, that this same line of research also tells us that technology does not always impact teaching and learning positively.[v] Therefore, it is important to examine individual tools more closely to determine their effectiveness. Such an undertaking is particularly critical for mobile apps and digital games as there are literally millions of apps and games available. Teachers and parents have no way of knowing which apps/games are pedagogically sound and/or useful for instruction.

Research does exist that explores the potential of math games, but less work has been done on the use of interactive math learning games for early elementary and preschool ages. This study set out to expand that research by looking at an interactive learning game aimed at Kindergarten called *Zorbit's Math Adventure* (zorbitsmath.com). *Zorbit's Math Adventure* is a series of math games that provides math engagement for students in Pre-K through second grade, with third grade in development. The games, built for *Apple IOS* devices and laptop/desktop computers, provides students with engaging gameplay aligned to varying North American content standards. The games provide both personalized learning to the student as well as a dashboard for continued teacher monitoring and evaluation.

> …after only three weeks of use, preschool-aged students [using *Zorbit's Math Adventure for Preschool*] had growth equivalent to the difference between two children approximately six months apart in age.

Early research had provided evidence of significant growth with student use of *Zorbit's Math Adventure for Preschool*.[vi] More specifically, after only three weeks of use, preschool-aged students had growth equivalent to the difference between two children approximately six months apart in age. The purpose of this study was to build upon that early work to examine the use of interactive learning games in Kindergarten.

Methods

Data were collected from 89 children enrolled in Kindergarten in a suburban school district located in Ontario, Canada. Students in the study were on average 5 years of age (*M* = 5.32 years) and were relatively evenly split in gender (51.7% male and 48.3% female). The students were randomly assigned to the treatment or control condition such that three classes were assigned to each condition. Children and their parents / guardians were provided with information about the study, with parents providing signed consent for participating students, and children providing verbal assent. Teachers in the treatment group were asked to provide students (*n*=56) with a minimum of 3 twenty-minute instructional opportunities each week to play *Zorbit's Math Adventure for Kindergarten* (Numbers) for a total of 8 weeks. Students in the control group (*n*=33) conducted business as usual. Both groups were given the TEAM[vii] pretest and posttest. The TEAM assessment includes a series of mathematical tasks, with certain tasks including images, and others including the use of physical manipulatives. The assessment has been statistically validated and includes an Item Response Theory (IRT) scoring table. Both control (*M* = -4.61, *SD* = .70) and treatment (*M* = -4.79, *SD* = .76) were found to have statistically similar pretest scores (*t* (df=87) = 1.10, *p* = .28). Therefore, the treatment assignments were considered sufficient.

Analysis and Results

A multiple regression model was used to examine the statistical effect of the treatment, while accounting for various factors (*pretest* scores, gender, age).

$$(MathScore)_{post} = \beta_0 + \beta_1 \cdot (Age) + \beta_2 \cdot (MathScore)_{pre} + \beta_3 \cdot (Treatment) + \beta_4 \cdot (dMale) + e$$

The outcome ($MathScore_{post}$) represents a child's score for the *posttest* TEAM assessment. β_1 is the average effect of a child's age in years on their posttest score. This effect, β_1 = .13, was found to be statistically significant at the .10 level (p = .060). So, for every year a child aged, their posttest score would, on average, increase by .13 points due to age alone. *Pretest* scores were also found to be a statistically significant predictor of *posttest* scores (β_2 = .82, $p <$ .001). Gender was dummy coded (dMale) and was found not to have a statistically significant effect (β_4 = .05, p = .35). However, treatment was found to have a statistically significant effect on *posttest* scores, when accounting for other factors in the model (β_3 = .15, p = .010). This effect size, while modest, is slightly larger in magnitude than the effect associated with age in years.

...students assigned to the treatment condition who played the Zorbit app saw a similar amount of growth in their mathematics achievement scores as that associated with one year of natural growth.

Thus, students assigned to the treatment condition who played the Zorbit app saw a similar amount of growth in their mathematics achievement scores as that associated with one year of natural growth. This is not to suggest that the effect associated with the treatment placed students at the level of first grade students, but that the statistical effect is similar to that observed with natural growth in the present sample (i.e., that associated with differences in age for the present sample between 4 and 6 year olds). Lastly, the overall model illustrated in Equation 1 was found to be statistically significant (F (df=4) = 55.46, p < .001) and had an R^2 value of .85, suggesting the model explained 85% of the variance in children's posttest scores.

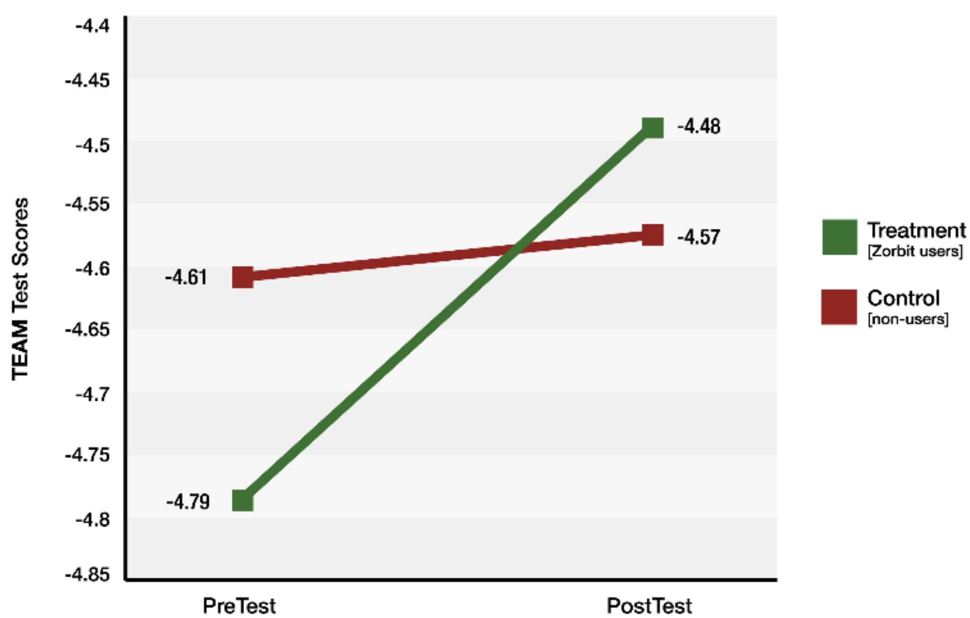
Discussion & Conclusion

There are two key findings in this study. First, research results provided evidence that students using an interactive learning game saw statistically significantly more growth. This suggests the tools like *Zorbit's Math Adventure* may be an important part of a teacher's toolbox for Kindergarten math instruction.

Second, for Kindergarten, TEAM assessment theta test statistics between -2.88 and -1.03 indicate a child is on grade level performance. The present sample for both groups (treatment and control) had an overall pretest score that was below grade level (M = -4.72, SD = .74). This finding suggests that students with lower demonstrated mathematical achievement may need significantly more time working on tasks at and below grade level. Future studies should examine whether giving students access to games below grade level would serve as a useful introduction for at-level games or apps.

The challenge for teachers, of course, is that not all students will require this. Teachers will need dynamic cross-grade technologies that will easily allow them to personalize and adapt learning and content to student needs at, above, and below grade level. Such an implication calls for multiple grade-level technologies that can easily be implemented dynamically by teachers and parents.

Zorbit Test Results



Key Finding: Zorbit users' improvement over 8 weeks is roughly the equivalent of one year's natural growth.

Endnotes

[i] Tamim, R. M., Bernard, R. M., Borokhovski, E., Abrami, P. C., & Schmid, R. F. (2011). What forty years of research says about the impact of technology on learning a second-order meta-analysis and validation study. *Review of Educational Research*, 81(1), 4-28.

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[iv] Trujillo, K., Chamberlin, B., Wiburg, K., & Armstrong, A. (2016). Measurement in Learning Games Evolution: Review of Methodologies Used in Determining Effectiveness of Math Snacks. *Technology, Knowledge and Learning*, 21(2), 155-174.

[v] Ferdig, R.E. (2006). Assessing technologies for teaching and learning: Understanding the importance of technological-pedagogical content knowledge. *British Journal of Educational Technology*, 37(5), 749-760.

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[vii] Clements, D. H., Sarama, J., & Wolfe, C. B. (2011). TEAM – *Tools for early assessment in mathematics*. Columbus, OH: McGraw-Hill Education.