KIU Journal of Humanities Copyright©2020
Kampala International University ISSN: *2415-0843*; 5(3): 315–319

Digital Mathematical Games and Students' Confidence in Technology Use: Assessing Effects on Achievement in Mathematics Test

JOSIAH OWOLABI
National Open University of Nigeria, Abuja

Abstract. This study investigated the effects of digital mathematical games and confidence in technology use on achievement in mathematics test among Lagos state Junior secondary school students. The design of this study was the quasi-experimental design. The targeted population for this study was Junior Secondary two (2) students in Lagos State, Nigeria. The sample comprised of 40 subjects distributed across 2 groups in two separate schools (20 in experimental group and 20 in control group) purposively selected. The control group was taught using the conventional teaching approach while the experimental group was taught using the mathematical game called "2bases car race". A mathematics achievement test (essay type) and confidence in technology use scale were used for the study. Two experts (one in mathematics education and one in test and measurement validated the two instruments). Corrections identified were effected before administering them to the study participants. Cronbach alpha was used for the reliability coefficient of the items in "Confidence in technology use" scale using the SPSS software. The reliability coefficient was found to be 0.820. ANCOVA and multiple comparisons were used in testing the three (3) null hypotheses raised. The result of the analysis indicated that the main effect of treatment and "Confidence in technology use" were not statistically significant. It was recommended that further researches using advanced and abstract topics in mathematics be carried out.

Keywords: Effects, Digital Games Mathematics, Confidence in Technology use, Achievement, Test

1. Introduction

Achievement in mathematics seems to be of special significance especially to societies that require their workforce to be mathematically literate. Therefore, success in mathematics is one of the criteria that must be met before consideration for admission to study any course at any tertiary institution. Teaching and learning process of Mathematics in Nigeria has mostly been through the traditional method of teaching, which could not take care to a large extent the various domains of learning. According to Oblinger and Oblinger (2005); Ogunbode (2015) the pedagogy used to pass across learning in mathematics class is teacher centered and does not cover all the stages of learning taxonomy except for the cognitive domain. Hence, the affective and the psychomotor are left uncovered.

According to Smith (2013), teachers who use technology wisely can extend the knowledge of every student, from the student who is gifted to the student who needs a different medium in which to learn. Students understand abstract concepts better when provided with more realistic visualisations. For instance, it is easier to see how the variable m in $f(x) = mx + c$ represents a rate of change when the function is graphed and students can explore the connection between m and the gradient (slope) of the line (Roschelle, Tatar, Shechtman, Hegedus, Hopkins, Knudsen, & Stroter, 2007).

The use of digital mathematics games in instruction becomes necessary given the fact that today's young learners, exposed to digital media appear to be disposed to learning using technology (Prensky, 2001). The features of digital games, which include interactivity, engagement, and state of the art of computer technologies, have high multi-sensory rendering environment, hence students are opportune to learn by doing. Besides, schools are beginning to accept and absorb technology as an essential part of their curricula (Ozel, Yetkiner & Capraro, 2008). Many of the studies on game-basesd learning have focused on digital game-basesd learning. Digital games provide animated graphics and audio effects as well as immersive stimulation. Lin and Liu (2009) included game mechanisms in typing practice, inviting learners to beat their rivals. Although the progress of these learners was not significantly greater than that of learners using conventional learning techniques, their typing skills were significantly better than before the experiment. Lin and Liu (2009) also observed that learners in the game mechanism group spent considerably more time practicing typing than their counterparts in the regular class, thereby demonstrating that multimedia can influence the learning motivation of students.

Educators who use digital games as instructional tools reported positive effects on students learning in variety of disciplines (Frankline, Peat & Lewis, 2003; Koether, 2003). The findings of empirical studies revealed that instructional digital games could promote learners mathematical performance (Ke & Grabowski. 2007; Kebritchi, Hirumi & Bai, 2010; Lee. Luchini, Michael, Norris & Soloway, 2004; Pareto, Arvemo, Dahl, Haake & Gulz, 2011, Pill & Aksu, (2012). Souter (2002) conducted an action research study aimed to compare the effects of technology enhanced algebra instruction and traditional algebra instruction in terms of student academic achievement, student motivation, and student attitude towards algebra. The study included four teachers and 92 ninth-grade students in five algebra classes. The results revealed that students in technology-enhanced classes had higher achievement scores, were more motivated, and had a more positive attitude than those in traditional algebra classrooms.

The use of technology must be properly carried out to enjoy its benefits. Accroding to Seefldt, Galper & Stevenson-Garcia (2012) if the technology is used well in the classroom environment, it will offer many advantages affect on students achievement, such as individualizing instruction, providing intermediate feedback, and offering games that motivate substantial mathematical thinking. Goldenberg (2000) also submits thus; "some problems in mathematics are too hard to be posed in a pencils only classroom; so they require students to experiment with certain objects to see how they respond. Some require visual representations—graphs, diagrams, geometric figures, moving images—that respond to students' questions, answers, or commands. This is the reason why beyond technology use for teaching and learning mathematics the issue of confidence level in technology use should be investigated. This research work therefore attempts to study how treatment (digital mathematical games) and confidence with technology use affect Juniour secondary school students' achievement in number bases operations.

2. Purpose of the study

Specifically, this study is embarked upon:

- To determine the main effects of treatment on students' achievement in number bases operations test
- To determine the main effect of confidence with digital games on achievement in number bases operations test
- To determine the interaction effects of treatment and confidence with digital games on students' achievement in number bases operations test

3. Research Hypotheses

The hypotheses are as follows:

- There is no significant effect of digital mathematical games (treatment) on students on student achievement in number bases operations
- There is no significant effect of confidence with digital games on achievement in number bases operations
- There is no significant interaction effect of treatment and Confidence with digital games on students' achievement in number bases operations.

Table 1: Summary of Analysis of Covariance (ANCOVA) of Post-test scores

Source	Type III sum of squares	Df	Mean Square	F	Sig.	Partial Eta. Squares
Corrected model	550.218	13	42.324	0.551	.870	.216
Intercept	22377.394	1	22377.394	291.262	.000	.918
Treatment	11.610	1	11.610	0.151	.701	.006
Confidence with technology use	98.662	2	49.331	0.642	.534	.047
Treatment* Confidence with technology use	4.144	2	2.072	.027	.973	.002
Error	1997.557	26	76.829			
Total	39941.000	40				
Corrected Total	2547.775	39				

a = R. Squared = .216 (Adjusted R squared =-0 .176)

Hypothesis One: There is no significant main effect of treatment on students' achievement in number bases operations

The result in table 1 indicate that the main effect of treatment (digital mathematics games) on students achievement in number bases operations is not statistically significant {F (1.40) = 0.151, p > 0.05)}. Since the p-value of the F ratio is not significant, it follows that hypothesis one regarding the main effect of treatment on students' achievement in algebra is accepted. Therefore there is no significant main effect of treatment on students' achievement in number bases operations. The partial Eta squared estimated was 0.006, implying that treatment accounted for only 0.06% of the variance observed in post-test achievement score.

Table 2: Scheffe post Hoc multiple comparison of treatment

Treatment (I) treatment	(J) treatment	Mean difference (I – J)	Std. Error	Sig.
Control	Experimental	-1.861	3.516	.601
Experimental	Control	1.861	3.516	.601

Table 2 above showed the mean differences of achievement scores of students exposed to the different treatment conditions. The result shows that there is no significant mean score difference between the groups. The experimental group however scored higher than their counterparts in the control group. The mean difference however is not statistically significant.

Hypothesis Two: There is no significant main effect of Confidence with digital games on students' achievement in number bases operations.

Table 1 also showed that the main effect of Confidence with digital games on students' achievement in number bases operations is not statistically significant {F (2.40) = 0.642, p > 0.05)}. Since the p-value of the F ratio is not significant, it follows that hypothesis 2 on the main effect of Confidence with digital games on students' achievement in number bases operations was accepted, hence, therefore there is no significant main effect of Confidence with digital games on students' achievement in number bases operations. This implies that the Confidence with digital games of the students do not have significant (generalizable) impact on their achievement in number bases operations. The partial Eta squared estimated was 0.047, implying that Confidence with digital games accounted for 4.7% of the variance observed in post-test achievement scores.

Table 3: Multiple Comparison of achievement in number bases operations across levels of Confidence in Technology Use

(I) TC	(J) TC	Mean Difference (I-J)	P-value
Low	Medium	-3.119	0.470
	High	1.461	0.741
Medium	Low	3.119	0.470
	High	4.580	0.271
High	Low	-1.461	0.741
	Medium	-4.580	0.271

A further attempt was also made to locate the difference in students' achievement in number bases operations across their levels of confidence with digital games with the aid of Scheffe post-hoc analysis (Table 3). From Table 3, the mean comparison showed that the achievement for those at the medium level confidence with digital mathematics games is highest, followed by those at the low level. Those at the high level of confidence with digital games are lowest. None of the differences in their mean achievement is however statistically significant. The differences in the sample might have occurred as a result of sampling error.

Hypothesis Three: There is no significant interaction effect of treatment and Confidence with digital games on students' achievement in number bases operations.

Table 1 also showed that there was no significant interaction between treatment and Confidence with digital games on students' achievement in number bases operations. Since F (2, 40) = 0.027, p > 0.05, the p value is not significant. Hence, the interaction of treatment and Confidence with digital games does not have significant (generalizable) impact on students' achievement in number bases operations. The partial Eta squared estimated was 0.002, implying that the interaction of treatment and Confidence with digital games accounted for 0.2% of the variance observed in post-test achievement in number bases operations.

4. Discussion

The results presented in the table 1 shows that the main effect of treatment was not statistically significant. This implies that the treatment did not improve the students' achievement in number bases operations, thus the findings of this study disagrees with the findings of Dochy, De Ridjt and Dyck (2002); Harackiewicz, Barron, Tauer and Elliot (2002); Thompson and Zamboanga, 2004) which in turn answers the question about the utility of prior knowledge in predicting student achievement. Thus there was no correlation in the effects of this study to the works of the researchers listed above.

5. Conclusion

The primary question in this study centered on the effect of the use of digital mathematical games with technology on mathematics achievement. The findings from this study showed non-significant effect of treatment and confidence with technology use on students' achievement scores.

6. Recommendations

- It is recommended that further research studies should focus on advanced and abstract topics in mathematics.
- Teachers are to be trained on the utilization of these educational games in order to ease the teaching and learning process
- Other mathematical games different from the "car race game" used in this study should be implemented in the teaching and learning of mathematics.

References

Bates, A. W., & Poole, G. (2003). Effective Teaching with Technology in Higher Education: Foundations for success. San Francisco, CA: Jossey-Bass. Battista,

M. S. (1978). The effect of Instructional Technology and Learner Characteristics on Cognitive Achievement in College Accounting. The Accounting Review, 53, 477-485.

Dochy, F.J.R.C., De Ridjt, C., & Dyck, W. (2002). Cognitive Prerequisites and Learning. How far have we progressed since Bloom? Implications for Educational Practice and Teaching. Active Learning in Higher Education, 3 (3), 265-284.

Franklin, S., Peat, M., & Lewis, A. (2003). Non-traditional interventions to stimulate discussion: The use of games and puzzles. *Journal of Biological Education*, 37(2), 79-84.

Goldenberg, P. (2000). Thinking (And Talking) About Technology in Math Classrooms. Issues in Mathematics Education, Education Development Center, Inc.

Harackiewicz, J.M, Barron, K.E, Tauer, J.M., & Elliot, A.J. (2002). Predicting Success in College: A longitudinal study of achievement goals and ability measures as predictors of interest and performance from freshman year through graduation. *Journal of Educational Psychology*, 94, 562–575.

Ke, F., & Grabowski, B. (2007). Gameplaying for maths learning: Cooperative or not? *British Journal of Educational Technology*, 38(2), 249-259.

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on Mathematics Achievement and Class Motivation. Computers & Education, 55(2), 427-443.

Koether, M. C. (2003). The Name Game: Learning the connectivity between the concepts. *Journal of Chemical Education*, 80, 421-423.

Lee, J., Luchini, K., Michael, B., Norris, C., & Soloway, E. (2004). More than just fun and games: Assessing the value of educational video games in the classroom. CHI 04 Extended Abstracts on Human Factors in Computing Systems, 1375-1378.

Lin, C. H., & Liu, E. Z. F. (2009). A Comparison between drill-basesd and game-basesd typing software. Lecture Notes in Computer Science, 5940, 48-58.

Oblinger, D, G, & Oblinger, J, L, (Eds.), (2005). Educating the Net Generation. Washington, DC: EDUCAUSE. Retrieved from http://www.educause.edu/research-and -publications/books/educating-net-generation.

Ogunbode, O., (2015). Effect of Mathematical Game and Gender on Students' Achievements in Algebra. A Project submitted to the Department of Mathematics Education Federal University of Technology, Minna.

Ozel, S.; Yetkiner, Z. & Capraro, R. (2008). Technology in K-12 Mathematics Classrooms. Short reports, 108 (2), 80-85.

Pareto, L., Arvemo, T., Dahl, Y., Haake, M. and Gulz, A. (2011). A teachable-agent arithmetic game's effects on Mathematics understanding, attitude and self-efficacy. In G. Biswas, S. Bull, J. Kay, & A. Mitrovic (Eds.), Lecture Notes in Computer Science: Vol. 6738. Artificial Intelligence in Education (pp. 247-255). doi: 10.1007/978-3-642-21869-9_33.

Pilli, O. & Aksu, M. (2012) The effects of computer-assisted instruction on the achievement, attitudes and retention of fourth grade Mathematics students in North Cyprus. Computers & Education. Advance online publication. doi: 10.1016/j.compedu.2012.10.010

Prensky, M. (2001). Digital Natives, Digital Immigrants. On the Horizon, 9(5), 1-5.

Roschelle, J.; Tatar, D.; Shechtman, N.; Hegedus, S.; Hopkins, B.; Knudsen, J. & Stroter, A. (2007). Can a Technology-enhanced Curriculum Improve Student Learning of Important Mathematics? (SimCalc Technical Report 1). Menlo Park, CA: SRI International. Available at: http://math.sri.com/publications/index.html.

Smith, S. (2013). Early Childhood Mathematics. Pearson Education, Inc., 5th Ed.

Souter, M. (2002). Integrating Technology into the Mathematics Classroom: An Action Research Study. Action Research Exchange, 1 (1).

Seefldt, C.; Galper, A. & Stevenson-Garcia, J. (2012). Active Experiences for Active Children. Pearson Education, Inc.,3rd Ed.

Thompson, R.A., & Zamboanga, B.L. (2004). Academic aptitude and prior knowledge as predictors of student achievement in Introduction to Psychology. *Journal of Educational Psychology*, 96, 778–784.