

Teaching Effectively with Use of Game-Based Interactive Mathematics

Hydon B. Libradilla, Karen Luz Y. Teves, and Aldwin M. Teves

Abstract— To accomplish one of the Department of Education goals that envisions each Filipino learner to possess sufficient mastery of basic competencies in both literacy and numeracy, skills in problem solving, creative and critical thinking, this quasi-experimental research study was conducted to determine if the use of interactive game-based mathematics lessons improved the pupil's mathematics performance in the classroom. It has been observed that pupils reaching higher grades in the elementary found difficulty in mathematics subjects because they have not mastered the fundamental operations well and replacing the traditional method of teaching fundamental math with interactive games is believed to create a difference and enhance learning. The main objective of this study was to determine if the use of nineteen interactive mathematics lessons improved the pupil's mathematics performance and ascertain if significant relationship occurs between pupils' responses on the features of the lessons and their performance after game-based lessons were launched. The study followed the Pretest-Posttest under Quasi-Experimental with Two Control Group research design employing 76 Grade Six pupil respondents of Don Cristito C. Tirambulo Memorial Elementary School, Mabinay District II in Paniabonan, Mabinay, Negros Oriental, Philippines. Results show that features of the games such as attractive color, graphics, sounds and time element makes learning more engaging, exciting and full of fun and thrill for the respondents. Majority of the games' features facilitated swift learning both in fundamentals and fractions, thus erases the respondents' perception of math as a difficult subject. There was significant increase in the respondents' performance and positive correlation between most of pupils' responses on the games' features and their performance. Based on the results, it is recommended that game-based math lesson be formally part of the Department of Education curriculum and trainings and seminars be conducted to orient the teachers in this classroom intervention for prompt implementation.

Keywords— Game-based math lesson, pupil, response.

I. INTRODUCTION

ONE of Philippine Department of Education Millennium Development Goals is a vision of A Filipino Learner who possesses sufficient mastery of basic competencies in both literacy and numeracy, skills in problem solving, creative and critical thinking (Ruiz, 2013). Mathematics and science

Hydon B. Libradilla is a Teacher III of the Department of Education, Mabinay District II, Mabinay Negros Oriental, Philippines (corresponding author's e-mail: cyfhydon83@yahoo.com)

Karen Luz Y. Teves is an Assistant Professor of Central Philippines State University, Kabankalan City, Negros Occidental, Philippines (kartevs@yahoo.ca)

Aldwin M. Teves is an Associate Professor of Central Philippines State University, Kabankalan City, Negros Occidental, Philippines (joiowen@yahoo.com)

proficiency is one of the 10-point educational Agenda of the country's president, thus, mastery of the four basic mathematical operations in the primary grades is a must to cope up with much higher logical and mathematical operations. If Filipino learner have strong foundation and mastery in mathematics and sciences, they can deal well much higher learning competencies as they continue to progress in their studies.

However, it has been observed that pupils reaching higher grades in the elementary found difficulty in mathematics subjects because they have not mastered the fundamental operations well. In addition, statistics show that the school performance in the recently concluded National Achievement Test (NAT) administered last March 2014, the Mean Percentage Score (MPS) of the mathematics subject is only 69.75% which is far from its target of 75% mastery level (DepEd, 2014). This low pupil's math performance indicates that pupils did not learn fully in the traditional teaching methods employed by the math teachers. Access to technology provides teachers and students with tools which, when constructively used, can create opportunities for enhanced learning of mathematics. One promising approach explored is the potential of computer games as tools for supporting mathematics teaching and learning (Mavrotheris, 2012). Research suggests that use of educational games is an effective means of improving students' attitudes towards mathematics. It has been shown that educational games attract and gain students' attention, contributing to their increased motivation and engagement with mathematics (Squire, 2005). Access to technology provides teachers and students with tools which, when constructively used, can create opportunities for enhanced learning of mathematics.

The main objective of this study was to determine if the use of nineteen interactive mathematics lessons improved the pupil's mathematics performance in the classroom. The study also sought to ascertain if significant relationship occurs between pupils' responses on the features of the lessons and their performance after game-based lessons were launched.

II. CONCEPTUAL FRAMEWORK

Teaching of mathematics is viewed as unappealing to the majority of students, as outdated and unconnected with their interests and experiences (Goodrum, Hackling, & Rennie, 2001). Thus, many students find learning mathematics difficult, and do not like studying mathematics. With the present scenario and reality in the Department of Education classrooms, with teachers having more than 50 pupils in a classroom, an alternative method based on Skinner's theory of

learning, such as the use of computer-assisted instructions (CAI) is anticipated to promote a more effective instruction.

A game-based lesson is much more appealing to elementary pupils because it is aided with computers and children are more engaged in computer games because of fun, curiosity and thrill. Since pupils display this kind of behavior in computer games, this gives the idea to have a guided interactive game based lesson to enhance the teaching learning process.

Pupil's performance is greatly affected as to how engaging teaching-learning process takes place. Elementary grade pupils are fond of playing, thus taking advantage to their interest of play, game based learning is introduced which deemed effective in getting pupils attention and positive performance. It is believed that fundamental mathematical operations games may foster learning in the pupils which will further help them solve a more complex math problems like fractions as an application. A pupil's response and outlook of the game-based lesson such as their excitement and curiosity and their point of view on how challenging is the game is considered an intervening variable (Figure 1). To some pupils they can easily grasp the concept of the topic however, there are pupils who find it difficult. This is explained in the theory of individual differences of Skinner, that students comes from different environments in which their leaning behavior has been shaped and reinforced in various ways. Therefore, what may be considered a positive reinforces for one student may not promote positive learning behavior for others.

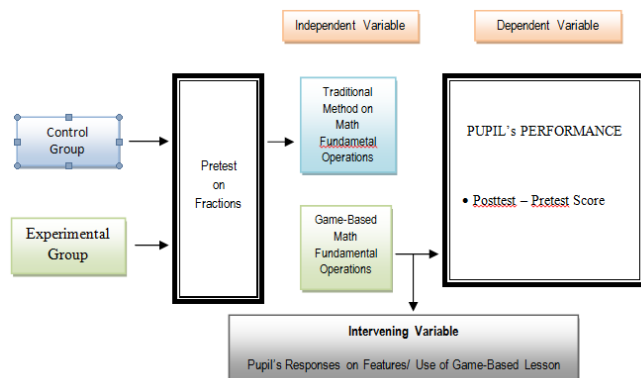


Fig. 1 Framework on the Interrelationship of Variables

III. METHODOLOGY

Research Design, Instrument and Responsibility of the Study

The study followed the Pretest-Posttest under Quasi-Experimental with Two Control Group research design. The design involved randomly assigned subjects between two groups, a test/experimental group and a control. Both groups was pre-tested and post-tested, and the difference was that the experimental group received Game-based Fundamental Mathematical operations lesson while the control group, with the traditional method of teaching. A researcher-developed instrument gathered the pupil's responses on the features of the game-based lessons on Mathematical Fundamental Operations as well as on Fractions. Test questionnaires for the pre-test and

post-test developed by the researcher was used to determine the effect of game-based mathematics lessons on the performance of pupils. For the selection of respondents, two Grade Six sections under the researcher was chosen to a total of 76 pupil respondents of Don Cristito C. Tirambulo Memorial Elementary School, Mabinay District II in Paniabonan, Mabinay, Negros Oriental, Philippines.

Data Analysis

To measure the effects of interactive game-based mathematics lessons on the pupil's performance, the t-test with two independent samples was used. To determine the pupil's responses on the game-based mathematical lessons, weighted mean was used. To determine if relationship exist between pupil's responses on game-based lessons and their performance, the Spearman Rank correlation was used.

IV. FINDINGS

Pupils Responses on the Features of Game-based Math Lesson

Game-based math lesson on fundamentals and fraction were taught to the pupil respondents and their responses on the game's features were gathered. The following game-based lessons downloaded from the internet were used in the classroom; Building expressions, Drill, Pirates, Cross the river, Car race, Drag race, Space race, Pop-up math division, Fruit Shoot Fraction, Snowball Fight, Tug Team, Math Man, Fruit Splat, Speed Way, Snow Splint, Genius Defender Fraction, Brain Racer Fraction, Fraction Division, and Fraction Number Bonds

(<http://www.math-play.com/adding-and-subtracting-fractions-game.html>)

(<http://www.mathnook.com/math/geniusdefenderfractions.html>)

(http://www.mathplayground.com/ASB_Speedway.html)

When pupils were asked if game-based lesson in math helped them to like the subject, majority of the students were neutral with their responses with mean score of 3.38 (Table I). In playing the fruit shoot fraction, majority of them find it difficult and this experience partly caused them to be neutral with their answers. Moreover, playing the said game contributed to neutral responses among pupils when asked how often they play fraction (WM=3.41) and when asked if they often play computer games (WM=3.31). This may be due to the limited time they have in playing computers and also because they only play during the class and vacant periods. The rest of the games such as drill, pirates, cross the river, car race, pop-up math division, tube mending and fruit shoot fraction resulted to majority of the students strongly agreeing that game-based math fundamental and fraction lessons were challenging, full of fun, helped them learn about fractions especially the car race, drag race and space race. Playing the building expressions and cross the river with color effects were the features that made the pupils consider the games as colorful (WM=4.77), thrilling (WM=4.95) as with the car race. Since the game is computer based, colors and graphics

are some features of the Fraction Games. All the respondents strongly agree that they like the colors and graphics in the fraction games. To them it's amusing and it catches their attention to pay attention and get engross of the game itself and eventually learn the skills developed.

Games also features the level of difficulty for the pupils to try the easy level and progresses to the difficult level. Majority of the pupils strongly agreed that in some easy levels, they could get hints from the colors of the fractions. To them color hints were helpful and they liked the level where color hints available for all fractions for it made the game easy for them. Games introduced to the pupils feature the time element. It is time bounded. Majority of them, strongly agreed that time element added more thrill in the game. Time added more excitement to do mental mathematical calculations to win or get a high score in the game. on the other hand, the time they spent in a certain game influenced them to try again and do better the next round, thus constant repetition made them master the skills introduced in the game. Special effects when they get the correct or wrong answers are also featured in the games. Majority of the pupils strongly agreed that they like the special effect that they could fill with any fraction they wanted to. As the pupils play the game, sounds in the game they play also keeps their attention in tune their mind setting. Sound effects added more satisfaction when they won and entice them to do better next round when they lost the game. Thus, majority of them said that they like the sound effects of the fraction games (WM=4.9).

As an effect of the game-based lesson in mathematics, 100% of the respondents say that they feel interested in attending the class because of the game. To them, they feel more relax and relieved from a traditional way of teaching mathematics which is lecture and do more computations on paper. They always wanted to stay in the e-classroom during their vacant time to play the game after our lesson. Majority of the activities set by the teacher are participated by the pupils because they made sure they can also play the game and return during vacant hours to master it and go the high score.

Effects of Game-based Mathematical Lessons on Pupil's Performance

To measure the performance of the pupils, the mean difference between posttest and pre-test scores of the pupils was obtained. There was significant difference between pre-test and post-test in both groups, implying that whether game-based math lesson is used or not, still post-test is higher compared to the pre-test, but not so high compared to the experimental group where fundamental math was taught with the aid of games. When the two groups' performance was compared, results revealed that there was a great difference between experimental group and control group, experimental group performed well with mean difference score of 66.05, while traditional group mean difference only got 33.07 (Table II). These implied that pupils' performance was maximized with the new strategy of math teaching which is game-based. Game-based math lessons catches more attention of the pupils

and influenced their performance positively. Pupils are very engaged in the activity and thereby mastering the skills in every game as they keep doing the activity.

TABLE I
PUPIL'S RESPONSES ON THE FEATURES OF GAME-BASED MATH LESSON

Statement	Responses					WM	DE
	SA (5)	A (4)	N (3)	D (2)	SD (1)		
Game-based math lesson helps me to like the subject	0.38	0.92	2.08	0.00	0.00	3.38	N
I often play computer games.	0.26	0.82	2.23	0.00	0.00	3.31	N
I like to learn math from computer games	4.10	0.72	0.00	0.00	0.00	4.82	SA
I like fraction games compared to other educational games played	0.64	0.62	2.15	0.00	0.00	3.41	N
Game-based math lessons are challenging	4.62	0.31	0.00	0.00	0.00	4.92	SA
The game was fun.	4.87	0.10	0.00	0.00	0.00	4.97	SA
The game helped me learn about fraction.	4.87	0.10	0.00	0.00	0.00	4.97	SA
I liked the colors and graphics in Fraction Game.	3.85	0.92	0.00	0.00	0.00	4.77	SA
I got hints from the color of the Fractions when answering questions	4.36	0.51	0.00	0.00	0.00	4.87	SA
I like all levels of each game	4.36	0.51	0.00	0.00	0.00	4.87	SA
I learned from all levels of each game	4.62	0.31	0.00	0.00	0.00	4.92	SA
Time element added more thrill of the game.	4.74	0.21	0.00	0.00	0.00	4.95	SA
I liked the special effect that I could fill with any fraction I wanted to.	4.62	0.31	0.00	0.00	0.00	4.92	SA
The levels of the fraction puzzle made the game more fun.	4.62	0.31	0.00	0.00	0.00	4.92	SA
I liked the sound effects in the fraction game.	4.49	0.41	0.00	0.00	0.00	4.90	SA
The sound effects in each game is important to me	4.87	0.10	0.00	0.00	0.00	4.97	SA
It is important for me to get a good score in each game	4.87	0.10	0.00	0.00	0.00	4.97	SA
I feel interested in attending my math class because of the games to play	4.62	0.31	0.00	0.00	0.00	4.92	SA

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree. WM = Weighted Mean, DE =

TABLE II

PUPIL'S RESPONSES ON THE FEATURES OF GAME-BASED MATH LESSON

Group	Mean Pre-test Score	Mean Post-test score	Mean Performance (Posttest-Pretest)	SD	Df	t	Sig
Control	18.18	51.26	33.08	8.70	38	23.72	.000**
Experimental	16.74	82.79	66.05	6.19	38	66.54	.000**

Relationship between Pupil's Performance and Responses on the Features of game-based Math Lessons

Since the controlled group is subjected to new strategy of teaching which is game based, pupils were solicited some ideas as to how they respond to the different features of the game-based lesson. Of the 18 responses of the pupils, 7 statements were negatively correlated with their performance such as; playing often the computer games, game-based lessons are challenging, helping them with fraction lessons, special effect, sound effects and score of the games. This result shows that even pupils often play computer games, even the game is challenging, and contains special effects like colors, graphics and sounds it doesn't guarantee that the performance of the pupils will be augmented or increased. As some reaction of the pupils who undergo with the game, the more challenging the game, the more they get excited hence they are pressured, thus they lost focus thereby sometimes lost the game. However, pupils are very much engage in the lesson since it is game-based. To note some factors why it is not an assurance because sometimes when pupils play the games their co-members are shouting, yelling because of excitement and trying to be the first one to get the correct answer. Because of in a hurry, they sometimes commit mistakes.

On the other hand, lessons in mathematics which is game-based will eventually let the pupils like the subject. When the pupils who play other educational game compared to fraction games the data below shows that they like playing fraction games because the game is related to their lesson about fraction thereby making their lesson learned in a new dimension. As they perceived fraction lessons are difficult but they find it easy this time because it is very engaging, it is fun, with color hints, and with certain level of difficulty which they can monitor their progress. These positive responses of the pupils in the features of the games can be seen in the result of their performance. The more pupils are engaged and find the game-based lesson fun the more they learn more and the higher are there performance.

The rest of the pupils' responses positively correlated with their performance such as playing the games helped them like the subject, the game as fun and thrilling with special effects including the levels as being played by the pupils which they considered helpful to them, which in a way correlates with their high performance in the post test right after game-based lessons was being introduced to them. Moreover, there are items in Table III like statement numbers 3, 8, 10, and 18 that shows no measure of variability because all the respondents of this group have the same responses scores.

TABLE III

RELATIONSHIP BETWEEN PUPIL'S PERFORMANCE AND RESPONSES ON THE FEATURES OF GAME-BASED MATH LESSON

Response	Correlation Coefficient
Game-based math lesson helps me to like the subject	.152
I often play computer games.	-.131
I like to learn math from computer games	-
I like fraction games compared to other educational games played	.267
Game-based math lessons are challenging	-.030
The game was fun.	.275
The game helped me learn about fraction.	-.130
I liked the colors and graphics in Fraction Game.	-
I got hints from the color of the fractions when answering questions	.089
I like all levels of each game	-
I learned from all levels of each game	.013
Time element added more thrill of the game.	.067
I liked the special effect that I could fill with any fraction I wanted to.	-.052
The levels of the fraction puzzle made the game more fun.	.099
I liked the sound effects in the fraction game.	-.207
The sound effects in each game is important to me	-.232
It is important for me to get a good score in each game	-.232
I feel interested in attending my math class because of the games to play	-

V. CONCLUSION AND RECOMMENDATION

Based on the above findings, this study concludes that pupils show interest to learn math because of the features of the game such as color and graphics, sounds and time element that makes it more engaging and fun. The performance of the pupils in mathematics was higher when game-based math lessons were introduced. Game-based math lessons which is perceived by pupils as engaging, exciting and full of fun erases their perception of mathematics as a difficult subject. It is recommended that game-based math lesson be formally part of the Department of Education curriculum and trainings and seminars be conducted to orient the teachers in this classroom intervention for prompt implementation.

REFERENCES

- [1] Deped Region 7. President Aquino's Agenda for Basic Education. <http://www.depedro7gov.ph/uploadedFiles/file/newsletter/13%20PRESIDENT%20AQUINO.pdf>
- [2] Goodrum, D., Hackling, M., & Rennie, L. (2001). The status and quality of teaching and learning of science in Australian schools: A research report. Canberra: Department of Education, Training and Youth Affairs.
- [3] Klawe, M. M. (1998b). When does the use of computer games and other interactive multimedia software help students learn mathematics? *Journal of Curriculum Studies*, 30(3), 293-318.
- [4] Krendl, K. A., and Lieberman, D. A. (1988). Computers and learning: A review of recent research. *Journal of Educational Computing Research*, 4(4), 367-389. <http://dx.doi.org/10.2190/BP7R-8Y2Y-R57C-5JKL>
- [5] Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, 5(4), 333-369. http://dx.doi.org/10.1207/s15516709cog0504_2
- [6] Mavrotheris, M. 2012. Game-enhanced mathematics learning for pre-service primary school teachers. *Open University of Cyprus ICICTE 2012 Proceedings* 455 from <http://www.icicte.org/Proceedings2012/Papers/12-1-Meletiou.pdf> Date Retrieved : August 15, 2014

- [7] Mayes, J. T., and Fowler, C. J. (1999). Learning technology and usability: A framework for understanding courseware. *Interacting with Computers*, 11, 485-497.
[http://dx.doi.org/10.1016/S0953-5438\(98\)00065-4](http://dx.doi.org/10.1016/S0953-5438(98)00065-4)
- [8] Nastasi, B. K., and Clements, D. H. (1993). Motivational and social outcomes of cooperative computer education environments. *Journal of Computing in Childhood Education*, 4(1), 15-43.
- [9] Ruiz E.,(2013) Mathematics Education in the Philippines
<http://www.taimc2012.org/conference/education-philippines.pptx>
- [10] Squire, K. 2012. Changing the Game: What Happens When Video Games Enter the Classroom? *Innovate*, 1 (6).