

Development, Validation and Summative Evaluation of Card Pairing Games for Selected Math 8 Topics

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Abstract - *Traditional classroom situation where students are taught predominantly of lecture-discussion method put the classroom in a mathophobic atmosphere. Oftentimes, students exposed to this classroom atmosphere lead to math anxiety and eventually hate the subject and the teacher. Addressing this, varied interactive strategies to create an atmosphere of discourse has been developed and promoted. The use of instructional games has been viewed as one strategy that promotes active learning inside the classroom. Instructional games support constructivist learning and social learning.*

This study is aimed at developing, validating and evaluating card pairing games for specific topics in Math 8. The Research and Development model (R& D) was used. The card pairing games was validated by subject experts and experts in developing games. In evaluating the card pairing games, the Quasi-Experimental Pretest-Posttest design was used.

There are six card pairing games developed for specific topics in Math 8; the card pairing game is highly valid based on the result of the validation; Students exposed to card pairing game become more intact (homogeneous); Students exposed to card games enhance academic performance.

It is recommended to test the effectiveness of card pairing games to other group of students; Encourage math teachers to use the developed math card pairing games for classroom instruction; Develop other card pairing game for specific topics in math .

Keywords: *Educational games, Card pairing game, Mathematics education*

INTRODUCTION

Mathematics education has long been accepted as a major factor in development. How students learn and how to measure student performance in this area is thus a priority concern of policy makers and teachers worldwide . However, in spite of being given importance, Filipino students still perform low as revealed in International Association for the Evaluation of Educational Achievement or IEA [1]

Results of the Trends in International Mathematics and Science Study (TIMSS) in 2003 placed the Philippines in the lowest 10 percent of participating countries in Grades 4 and 8[2]. One of the key factors that contributed to the low performance in Mathematics is mathophobia or excessive fear of math [3] . Students with high math learning difficulties show high math anxiety [4]. Addressing this, teachers and educators endorsed that math is best learned through active student

involvement rather than just following teacher's direction [5]. Constructivistssupport this notion. Constructivism view that learning is an active, constructive process [6]. The underlying notion within the constructivism learning theory is the role which experiences-or connections with the adjoining atmosphere-play in student education [7]. Making the classroom as democratic, interactive and engaging stimulates an atmosphere that promotes learning [8]. Bakley et al. [9] emphasized that collaborative learning upholds positive interdependence and interaction among students. Instructional games have been used as a strategy for promoting student to student interaction inside and even outside of the school.

Instructional games are best for engaging learners with subject matter. Learners think that they are fun and very helpful [10]. They can be very effective for strengthening the course [11]. Educational Games is

built on theories such as situated learning [12], experiential learning[13] and activity theory[14].

Games hold a number of sociological welfares for players who play them. They have used for relaxation and as past time activity. Learning can be beyond classroom hours using educational games.

Studies showed that instructional games enhance learning and students exposed to games have better academic achievement [15, 16] and Math attitude. However, instructional analogy was found to be more effective in facilitating students achievement in Math than game [17].

Education.com developed card games for children to boost second grade math skills for fun and interactive learning experience [18]. Playing card games is a fun way to spend some time together and can also be a great way to help children improve their math skills[19]. Card games embraces a lot of benefits from sociological to developmental benefits [20] for children build skills while playing as well as imbibing good values such as honesty, integrity and sportsmanship [21]. Games can bring together ways of knowing, ways of doing, ways of being, and ways of caring [22]. Games also teach students that failure is inevitable, but not irrevocable. In school, failure is a big deal, in games, not so much. You can just start over from the last save. A low cost failure ensures that players will take risks, explore and try new things [23].

OBJECTIVES OF THE STUDY

This study is intended to design a matching card game for selected topics in Math 8; evaluate the card game using validation tool by subject experts and experts in game development; and test the effectiveness of the card pairing game as instructional material in teaching selected topics in Math 8.

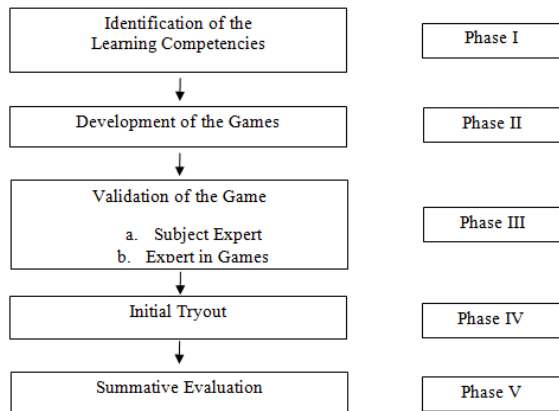


Figure 1. Conceptual Framework

Conceptual Framework

The development of the games for the selected mathematical topics is the basis of the conceptual paradigm of the study.

METHODS

Research Design

The researchers used the research and development (R and D) model of Borg and Gall [24, 25]. Here, educational game is developed, validated and evaluated.

Locale of the study

The researchers conducted the study at Apayao State College-Luna Campus. Validation of the instrument was done at Luna, Apayao district. Try out was done at San Francisco Agricultural and Technical School (at Luna district). Summative evaluation was done at Marag Valley Agricultural and Technical High School.

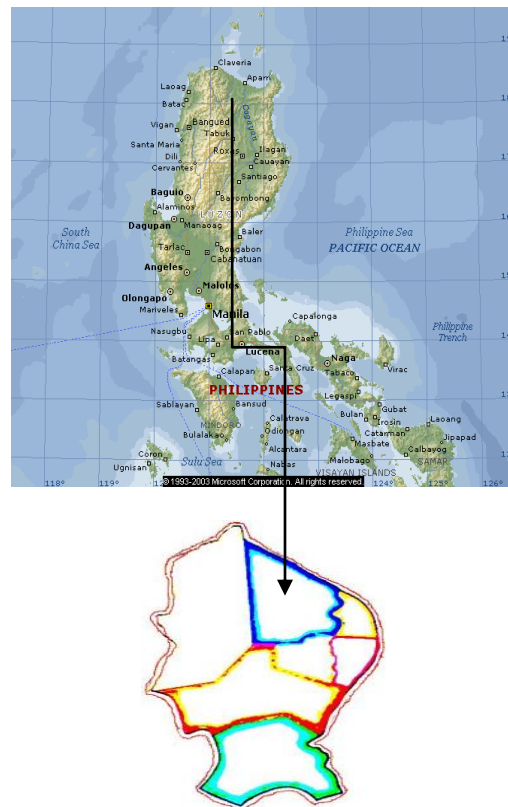


Figure 2. Map showing the locale of the study (Left: Philippine Map; right Map of Apayao)

Participants

The participating respondents of the study include 5 selected secondary Math teachers of Luna district, and 34 grade eight students of Marag Valley Agricultural and Trade High School. Said Math teachers are chosen using purposive sampling due to their expertise in Math and game development. They are chosen for the purpose of validating the card game. A total of 38 grade 8 students was used for the try out which was conducted at San Francisco Agricultural and Technical School. Both high schools are found in Luna, Apayao, Philippines.

Instrumentation

A. Face Validation Tool

Face validation tool was designed after models wherein questionnaire was used to evaluate the game. The following scale was used: 5 – highly valid; 4 – valid; 3 – undecided; 2 – not valid; 1 – strongly not valid. The questionnaire was used to determine the validity of the card game. It consists of four (4) sub – criterion as follows: the material used, rules, questions, and the matching card game itself. Space for comments and suggestions was also included below the questionnaire.

B. Achievement Test

The achievement test was administered to the respondents on a pretest and posttest basis. It consists of a 50- item test of a multiple choice type covering the topics on laws of exponents, ratio and proportion, factoring, integers, radicals and mathematical sentences. Originally, there were 75 test items but were trimmed down to 50 items after items were subjected to validation and item analysis. In order to achieve high degree of content validity, the suggestions of experts was sought. A table of specification was prepared which include the subject content, percentage or proportion of items in each area, and the cognitive processes involved .

To check on content validity, the initial draft of the instrument was given to a group of secondary Math teachers. All suggestions for improvement of the instrument were incorporated. After finalization of the second draft, this was pretested to two Math classes. Item analysis follows to determine the item of discrimination and item difficulty. For the item analysis, there were two criterion groups, the top 27% and the bottom 27% based on scores. The accepted level of index of difficulty is 0. 25- 0.75. On the other

hand, 0.20 – 0.40 is the acceptable level of discrimination for each item. 0. 40 and above is highly acceptable. Below 0.20 is not acceptable.

The reliability of the test was taken using the split half method. For every students, the number of correct answers in all even and odd items was counted and tallied in two separate columns. Another column was prepared for the students’ total scores in the exams. To correlate the odd –numbered scores and the even – numbered scores, the Pearson’s r was used. The result was the reliability of the half test. The reliability of the whole test was taken from the formula

$$r_{wt} = 2 r_{ht} / (1 + r_{ht}) \quad (1)$$

Where r_{wt} - reliability of the whole test
 r_{ht} - reliability of the half test

Teacher made test commonly have reliabilities somewhere between 0.60- 0. 85. Using split half method, the reliability coefficient of the whole test is 0.80

Data analysis

Data was gathered through the uses of face validation tool as guide in determining the respondents’ feedback regarding the matching card game after exposure.

The face validation tool was then administered for the purpose of games’ validity. After which, the answered questionnaires were collected then tabulated, analyzed and interpreted. The weighted mean was solved then the grand mean was used for the general interpretation of the responses. The table shows the limits of description and its verbal description for the scales used in the study.

Table 1.Limits and verbal description from the scale used in the study.

Scale	Limits of Description	Verbal Validity
5	4.20 – 5.00	Highly valid
4	3.40 – 4.19	Valid
3	2.60 – 3.39	Undecided
2	1.80 – 2.59	Not valid
1	1.00 – 1.79	Strongly not valid

RESULTS AND DISCUSSION

The Game and its Rules

The Goal of the Game

- The aim of the game is to be the first clear all his/her cards by matching the question-

cards (consist of the questions) to the answer-cards (consist of the answer) or vice versa.

Commence Playing

- Each of the players will pick a card from the question cards and pair it with answer the question. The first player who answers the question correctly will be the first player to draw. After identifying the first player to draw, the answer cards will be mixed to the question-cards. After mixing the cards well, the stock pile (unmatched cards) will be distributed clockwise beginning from the first player.

The Draw

The first player must begin by taking one card from the stock pile of his/her opponent right to

him/her. The stock pile he/she picked will be added to his/her own stock pile finding its match.

Melding

- If you have a valid pair of card match in your hand, you may lay one such combination face up on the table in front of you.

Continue playing

The next player to draw on his/her opponents stock pile on his/her right is the player where the first player picked a card. Then, proceed to melding. Repeat. The first player who lays paired cards (answer and question card) will be declared winner.

Table 2. The card pairing games, topics where the game can be incorporated and sample pictures

Topics (name of card game)	Sample picture (question card)	Sample picture (answer card)
Laws of Exponent	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> Question: Simplify: $(x^3)^5$ </div>	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> Answer: x^{15} </div>
Factoring	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> Question: Factor: - </div>	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> Answer: $(x - 3)^3$ </div>
Integers	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> Question: Simplify: </div>	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> Answer: -1 </div>

Ratio and Proportion	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> <p>Question:</p> <p>Solve for n:</p> </div>	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> <p>Answer:</p> <p>$n = 10$</p> </div>
Radicals	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> <p>Question:</p> <p>Rewrite into Radical Form:</p> </div>	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> <p>Answer:</p> <p>$\sqrt[4]{x^3}$</p> </div>
Mathematical Sentences	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> <p>Question:</p> <p>Rewrite into Mathematical Equation</p> </div>	<div style="border: 2px solid black; padding: 10px; width: fit-content; margin: auto;"> <p>Answer:</p> <p>$x + 6$</p> </div>

Table 2. Result of the validation made by the teacher and students on the developed card game in some specific criteria

Criterion	Computed Mean	Descriptive Value
Materials used are:		
• Suited to the activity	3.94	Valid
• Made up of local materials	3.97	Valid
• Easy to use	4.00	Valid
• Appropriate to the game	4.21	Highly valid
• User – friendly	4.47	Highly valid
Mean	4.12	Valid
The rules are:		
• Easy to follow	4.27	Highly valid
• Definite	3.94	Valid
• Concise and clear	4.18	Valid
Mean	4.13	Valid
The questions are:		
• Based from mathematics subject	5.00	Highly valid
• Clear and easy to understand	3.85	Valid
• Challenging	4.06	Valid
Mean	4.30	Highly valid
The matching card game is:		
• Captivating	4.09	Valid
• An aid to enhance the student learning ability	4.44	Highly valid
Mean	4.27	Highly valid
Overall Mean	4.21	Highly valid

The table shows the respondents' feedback after the card game was shown to them for utilization during its validation. The mean in its criterion showed the score ranging from 4.12 to 4.13 which means that the respondents says valid to the use and the rules of the matching card game and the score ranging from 4.27 to 4.30 which means that the respondents says highly valid to the questions and the matching card game itself. The grand mean showed the score of 4.21 which justifies that the matching card game is an effective learning tool to enhance the student's learning ability for teaching selected topics in mathematics subject.

Summative Evaluation

The quasi-experimental pretest –posttest single group design was used to evaluate effectiveness of the instructional card game. The pretest and the posttest are compared using the t-test and the result is presented in Table 3.

The table reveals that the mean of the pretest and the posttest are 20.71 and 23.88 respectively. A mean increase of 3.17 was observed from pretest to posttest.

It is also noted that the standard deviations of the pretest and the posttest are 4.84 and 3.76 respectively. It is interesting to note that after the card pairing game was introduced to the students, they become more intact as seen in the posttest standard deviation of 3.76. Games make all kinds of learning easier whether played in the classroom or at home. Children relax while they play and they concentrate. They don't mind repeating certain facts or procedures over and over, if repetition is part of the game. Games are also thought to be effective tools for teaching intricate ideas because they (a) use action instead of explanation, (b) build personal motivation and satisfaction, (c) accommodate various learning styles and skills, (d) strengthen mastery, and (e) offer collaborative, decision making environment [26, 27].

According to the Federation of American Scientists, People acquire new knowledge and complex skills from game play, suggesting gaming could help address one of the nation's most pressing needs – strengthening our system of education and preparing workers for 21st century jobs [28].

Table 3. Scores of the respondents in the pre – test and post – test examination before and after the game

Respondents	Pre-test	Post-test	Respondents	Pre-test	Post-test
A	14	19	R	27	29
B	20	26	S	27	28
C	21	25	T	27	27
D	21	22	U	26	24
E	19	23	V	25	26
F	18	26	W	25	29
G	17	21	X	24	20
H	17	19	Y	23	28
I	18	25	Z	23	25
J	17	23	AA	23	20
K	15	20	AB	21	27
L	16	18	AC	21	24
M	15	21	AD	20	27
N	20	23	AE	19	22
O	29	29	AF	19	25
P	28	29	AG	12	18
Q	28	29	AH	9	15
Mean Pretest				20.71	
Mean Posttest				23.88	
Standard Deviation Pretest				4.84	
Standard Deviation Posttest				3.76	

Table 4. The t-test of the pretest and posttest scores

Tests	Mean	Sd	Computed t	Tabular t 5%
Pretest	20.71	4.84	2.98*	1.67
Posttest	23.88	3.76		

*Significant

Table 4 shows the mean, standard deviation, computed t and tabular t value @ 5% level of significance. The computed t-value (2.98) is greater than the critical value of t at 5% level of significance (1.67). This means that difference in the mean scores of respondents in the posttest and pretest is significant. This further explains that card pairing game enhances student's academic performance. This finding finds support from the study of Kebritchi, Hirumi and Bai[29] when they found that Students who played the math video games scored significantly higher on the district-wide math benchmark exam, $F(1, 188) = 6.93, p < .05$, and on the math performance test generated by the publisher, $F(1, 188) = 8.37, p < .05$, than students who did not play the games. Further they emphasized that Higher achievement scores and greater gain scores on district benchmark tests by students who played the games, compared to those who did not play the game are particularly significant because there is a high correlation between the district math benchmark tests and the statewide math FCAT tests

CONCLUSION

There are six card pairing games developed for specific topics in Math 8. The card pairing game is highly valid based from the result of the validation. Students exposed to card pairing game become more intact as manifested in the posttest computed standard deviation. Students exposed to card games enhance academic performance as students can learn by doing something as a part of a larger community engaging in dialogue, setting common goals and achieving these goals.

RECOMMENDATIONS

It is recommended to test the effectiveness of card pairing games to other group of students; encourage math teachers to use the developed math card pairing games for classroom instruction; and develop other card pairing game for specific topics in math. Testing the effectiveness of the card pairing games is limited to pretest-posttest single-group design. It is therefore recommended for further testing using other

experimental designs such as the Solomon's four group design and pretest -posttest two group design.

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