

Game Multimedia in Numeracy Learning for Elementary School Students

D Rohendi^{1*}, N Sumarna², H Sutarno³

¹ Mechanical Engineering Education Department, Universitas Pendidikan Indonesia, Bandung, Indonesia

² Mechanical Engineering Education Department, Universitas Pendidikan Indonesia, Bandung, Indonesia

³ Computer Education Department, Universitas Pendidikan Indonesia, Bandung, Indonesia

*dedir@upi.edu

Abstract. Numeracy is one of the basic skills for elementary students to understand further concepts of mathematics. However teaching numeracy is still using recitation that can overload student's memory and make them reluctant to learn mathematics, so an innovative way by using multimedia to attract student interest in numeracy is needed. Therefore, the purpose of this study are: 1) to develop numeracy learning multimedia for elementary school students; and 2) to find out whether the implementation of numeracy learning multimedia can improve the students numeracy skills, and how is the response of elementary school students by using multimedia in learning numeracy? The results showed that multimedia can improve students' numeracy skill which is quit medium and the student response by using multimedia in numeracy learning are good.

1. Introduction

Numeracy is one basic skill of mathematics used in everyday activities which is very important. Thus, this concept has been given since elementary school. It is a basic skill for students to learn mathematics concept further. Numeracy on the elementary school dominates all part of mathematics concepts. Therefore, numeracy is strongly emphasized [1]. Numeracy is inseparable from mathematics. Numeracy is available in other mathematics branches such as algebra, geometry, statistics, probability, and topology [2].

Learning numeracy is not always smooth. Moreover, there is a presumption that mathematics is one of the difficult subjects and less liked by most students. In fact, many of students are complain that mathematics makes them reel and stress. Moreover, those who teach mathematics are often quick tempered, stigmatize and give punishment frequently as well as lecture in a faster and monotonous way [3].

So far, numeracy has been conducted through conventional method such as memorizing. Teachers have not been optimized in using media. This kind of learning is clearly imprecise, since the memory of children is limited. They remember things which are visible only. Memorizing will only overload



the brain. Therefore, students will be reluctant to learn math and decrease learning motivation and numeracy ability. Research results in 2012 showed that the average numeracy ability of grade 2 and 3 is 5.54. Such data is believed to be not only occurred in 2012, but also in recent years and occurred in almost all regions of Indonesia [4]. By considering the subject is children in elementary school which is under of 12 age and still like to play, then learning numeracy should be in the form of game. Since memorizing is emphasized in learning numeracy which is boring, then it is time to learn fun numeracy by game multimedia learning.

Game development during few years has been increasing rapidly. The first computer game that was created in 1952 by Alexander Douglas [5]. Since then, the purpose of game developments continues to grow. It was affected by the development of the reasons why people play games. There are some common reasons why people play game, such as entertainment, exploration, and fantasy, proving oneself, social lubrication, exercise, needs for acknowledgement, and also educational reasons [6].

Optimization of multimedia or technology usage in teaching mathematics should be increased [7]. Teacher-centered learning has now changed into student-centered learning. A one way learning has changed into multidirectional learning. Conventional learning has also changed into multimedia learning. Advances in technology and the development of new and powerful educational tools brought technology integration into instructional practices [8]. It increases teachers' productivity in teaching and engages students in their learning of mathematics [9].

Multimedia has advantage especially in delivering message to make the material clearer, because of composition elements such as text, sound, animation, video, and interactivity. Multimedia games allow students to be more active in learning, since they are encouraged to be independent and as if engaged in his/her own situation experienced [10]. Learners engage in the cognitive process known as multimedia learning [11], [12]. This research would like to unveil how to make students having interest and motivation in numeracy, the same as when they played games by using games multimedia. The problems proposed in this paper are: 1) How to develop numeracy learning multimedia for elementary school students; and 2) Are there any improvement of student's numeracy skills after implementation of numeracy learning multimedia, and how is the response of elementary school students by using multimedia in learning numeracy?

2. Games Based Multimedia

In general multimedia is a combination of various media such as text, images, video and animations in one computer-based program that facilitates interactive communication [13]. That as any other educational media, multimedia remains as tool, method and approach used to establish communication between teachers and students during teaching and learning process [14].

Media in learning process is a supporting component. A teacher who conveys the material without using media is not considered failed. Therefore, media plays an important role in guiding the learning process and results. The advantages of teaching by using media, including interactive multimedia [14], are as follow:

- Provides a deeper understanding of material explained, since it explains a difficult concept into a simple one.
- Able to explain abstract materials or objects into concrete.
- Helps teacher to present material easier and faster, so that students will easily understand. The material will also be long remembered as well as easily to be re-expressed.
- It is interesting and excites attention, interest, motivation, activity and learning creativity of students as well as entertaining.
- Makes students participate in the learning process and gives a deep impression to them.
- Learning material can be re-playback, for example by using video record, compact disk, tape recorder or television.
- Able to form the same opinion and the right perception toward an object since it is not only verbally conveyed, but also real.
- Create a conducive learning environment. Students are also able to communicate and interact with their learning environment so it gives a real experience.

- Establishes students' attitude in the aspects of affective, cognitive as well as increase psychomotor ability.
- Students learn in accordance with their characteristics, necessity, interest and talent either individual, group or classical, and saves times, energy and cost.

The development of interactive multimedia has to fulfil several criterion in [15], such as:

- Ease of navigation. An interactive multimedia should be designed as simple as possible so that students will learn easily.
- Cognition. It means that the material contains a clear knowledge.
- Information presentation is used to assess content and the interactive multimedia itself.
- Integrated media, means that the media should integrate the aspects of knowledge and skill.
- Artistical and aesthetics. To attract learning interest, the program should have an artistical and aesthetics display.
- The overall function. In other words, the program developed should fulfil learning desired by students.

In recent education, interactive media is getting evolved. There are many types of media that can be developed by teacher. There are several interactions which can be applied in designing learning media, such as games [16]. Instructional games is one form of modification of the games exist in a computer program, yet the packaging contents is adapted to the material relates to learning. Basically games are designed for the learning purposes, so that the game is presented in accordance with the purpose of learning.

The principles in using games in [17] are as follows:

- Students are required to have a clear concept of learning objectives contained in the games.
- Students must understand the procedures and rules of the games as well as the judgement.
- Make sure that the game is structured in such a way as to make all participants involve in the activity.
- It contains an initial explanation or discussion towards the conclusion of the game.

3. Horizontal Numeracy

Horizontal Numeracy is new and a completion of vertical Numeracy. There are three reasons underlying the statement [18], i.e based on the process of addition, subtraction, multiplication, and division.

First, the association concept of units, tens, hundreds, thousands, and so on in the traditional method to complete the process of addition or subtraction is of course already existed, but the emphasis is still less because of the separation between the value of the units, tens, hundreds, and so on are not explicitly marked by a separator notation. While in the horizontal concept, the association's concept on the value is firmly expressed by vertical bar. With the notations of vertical bar, the value of units, tens (l), hundreds (ll) and so on will be more easily understood and imagined. It is obviously an overview of metric needs to be explained first. Metric is a method of calculation conducted horizontally by using notation of the vertical bar. Vertical bar metricl, ll, ... is the 'box' containing the appropriate 1,2, ...,numbers in which if there is an excess, the remain will be moved to 'the box' on the left and summed up; however if it is less, a zero will be added to 'the box' without changing the value.

Second, the process to calculate the multiplication through the horizontal Numeracy turns out to be creating special patterns called as portals or horizontal patterns. Through the portal, the multiplication process becomes faster than the traditional one. For example, the square of the number 85 when conducted by using the horizontal method are as follows; $8 \times (8 + 1) \parallel 25 = 72 \parallel 25$, the result is seven thousand two hundred and twenty-five. Single digit multiplication with any number by using a common metric is very easy because the brain needs not to store numbers since the requirement is only to master the multiplication 1 to 9.

$$3 \times 46 = 3 \times (4 \parallel 6) = 3 \times 4 \parallel 3 \times 6 = 12 \parallel 18 = 13 \parallel 8 = 138$$

$$9 \times 803 = 9 \times 8 \parallel 0 \parallel 3 = 72 \parallel 27 = 7227$$

Two, three-digit multiplication via Metric is the multiplication of two or three numbers, tens, hundreds of which are resolved by using the help of a gradual multiplication of one digit metric, until the final result is obtained, then drafted right align and resolved by using "Metris Menyerong (+M)".

For example:

$$312 \times 236 = \dots\dots\dots$$

$$3 \times 236 = 6|9|18 = 708$$

$$1 \times 236 = 2|3|6 = 236$$

$$2 \times 236 = 4|6|12 = 472$$

$$\text{————— +M}$$

$$= 7|2|0|4|3+8|7+6|2 = 7|2|1|5|1|3|2 = 7|3|6|3|2 = 73632$$

Third, the horizontal numeracy is a good intermediary teaching; from a traditional learning basic Numeracy into algebra. Algebra is a branch of Mathematics by having signs and letters to illustrate or represent the numbers. By using the horizontal Numeracy, in particular the multiplication completion by using a portal, the students are guided to know a variable value. This knowledge is a basic foundation of understanding an equation or function in algebra.

4. Methode of Developing Multimedia and Implementation

4.1 Developing Multimedia Methode

Steps conducted in developing numeracy multimedia learning includes: the analysis of software and hardware necessity, designing, development, and testing.

In analyzing step, researchers conducted introductory study in the form of exploratory and literature. Exploratory study was carried out by using browsing technique, i.e. the search for looking information about numeracy ability of elementary students and the media usage, including learning methods used. While the literature study was conducted by collecting writings both in the form of journals, books, and articles related to interactive multimedia that can be used in learning mathematics generally, especially in the numeracy. Continued with user analysis, software analysis, and hardware analysis for knowing a sufficient hardware is also needed so that multimedia will run well in minimum specifications of hardware. Then designing and developing step was also done. Pict 1 show the homepage on numeracy mutlimedia. A testing toward multimedia is conducted to make sure the functions run well. The testing is conducted by using blackbox testing. After that the multimedia is judged to be considered eligible by experts and the repair related to theirs suggestion and recommendation.



Figure 1. Multimedia Homepage

4.2 Implementation Multimedia in Numeracy Learning

This multimedia was implemented to the fourth grade students of elementary school in Bandung city. The design in this implementation was a pretest - learning process – posttest. The concept of numeracy that be given, were the position of numbers, addition, subtraction, multiplication, and division. After learning numeracy with multimedia completed by the post-test. Then the students are given questionnaire to find out their responses toward the multimedia used. The implementation stage

is conducted to 33 students, with three times meeting/phase in a class. The following are the results of multimedia assessment after three times meeting/phase in a class:

The average results of pre-test and post-test as shown in Table 1 below:

Table 1. The Average Result of Pre-test and Post-test

Pre-test	Post-test	g
58.7	74.3	0.38

From the data in Table 1 shows that in general the average value of post-test results increased compared to the average value of pre-test. To find out the success level of multimedia usage in the numeracy learning process, the gain calculation had been done. The calculation was using an equation (1) as follows:

$$g = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \quad (1)$$

where,

g = Gain

S_{pre} = Posttest score

S_{post} = Pretest score

S_{max} = Max score

The gain result is 0,38. This result is counted to medium category. It means that the multimedia usage could increase student's numeracy skills. It can be observed by the class average results which are the average pretest result is 58.7 and the posttest average is increasing to 74.3.

Table 2. The Result of Student's Response Questionnaire.

Indicators	1st phase	2nd phase	3rd phase
Learning Goal Alignment	73%	75%	77,8%
Feedback and Adaptation	74%	75%	80,6%
Motivation	73%	74,3%	81,1%
Presentation Design	72,9%	73%	78,9%
Interaction Usability	68,5%	75%	78,5%
Accessibility	70,1%	73%	77,1%
Average	72.25%	73.88%	78,9%

Based on Table 2, that there was an increase in all indicators. In the aspect of learning goal alignment increased from 73% to 77.8%, feedback and adaptation increased from 74% to 80.6%, motivation from 73% to 81.81%, presentation design from 72.9% to 78.9% , interaction design usability from 68.5% to 78.5% and accessibility aspects increased from 70.1% to 77.1%. On average increase occurred in 78.9%. and considered as "good".

According to student responses as in Table 2, there are some aspects that are fixed on multimedia used in numeracy learning. Aspect that are fixed as shown in Table 3.

Table 3. The Aspet of Multimedia that Improvement

No	Description	Result of Improvement
1	Skip button is not available in the initial description of multimedia so user complained about a long description	Skip button has been added
2	There is an error on evaluation; it should be 40 minutes instead of 120 seconds. However, the time to finish evaluation has been right (40 minutes).	The description has been changed into 40 minutes.

After repair of the multimedia as in Table 3, includes completing the skip button and setting the time to evaluate the multimedia can be used in teaching math in elementary school.

The multimedia that used in this numeracy learning was design by considered some aspect, such as multimedia technology aspect and material aspect. The material aspect that is conducted based on the results of the preliminary observations and interviews with teachers of mathematics in the elementary school. Based on the difficulty level and also material needed, numeracy is the most subject which needed to use multimedia. Two concepts in numeracy which are difficult according to students are multiplication and division. The researchers applied games-based multimedia for learning horizontal numeracy. The core of this model is that the learning process of the students related to declarative and procedural knowledge which structured well and able to be taught with a gradual pattern of activity, step by step.

5. Conclusioan

Based on the research result, conclusions are obtained as follow: Multimedia is used in teaching numeracy developed in accordance with the steps appropriate multimedia development, by considering aspects of students' needs and the material being taught. Implementation of multimedia in numeracy learning in elementary school students can improve students' numeracy skills and students' response to the use of multimedia in teaching arithmetic in the category of 'good' in the aspect of learning goals, feedback and adaptation, presentation, interaction, and on accessibility.

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