# Developing E-Learning Based on Animation Content for Improving Mathematical Connection Abilities in High School Students

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**Abstract**

The purpose of this paper is to develop e-learning based on animation content to improve mathematical connection abilities in senior high school students. The e-learning was developed using framework proposed by Moddle, while the animation content was developed using macromedia flash. To get the student mathematical connection abilities, pretest and postest were administered before and after teaching and learning process. The data were analyzed using *t-test* and found that e-learning which was based on animation content not only had significant effect on mathematical connection abilities but also been able to improve students' mathematical connection abilities far better than that of conventional approach.

***Keywords:*** *e-learning, improving, animation content, mathematical connection abilities.*

## 1. Introduction

The electronic technology can be used to assist students in comprehending the visual images of mathematical ideas, it also facilitates students in organizing and analyzing data, and helps students to calculate in a quick and accurate way. One technology that can be used is computer. Dubinsky and Tall stated that the computer can be used as a tool to complement advantage mathematical thinking in a variety of ways [3]. Based on these advantages of the advance role of technology, in facing the challenges of the 21st century, it is necessary to develop various strategies, learning models, and to use an electronic technology-based learning media in such a way to create a pleasant atmosphere for both students and teachers.

In the past and even now, mathematical learning environment in Indonesia is often perceived as annoying, boring, and less stimulating, so the students are forced to learn in an unpleasant and less passionate way. These conditions should be changed into a passionate and meaningful atmosphere for both teachers and students. This implies that in order to become an effective learning process, the students should be able to know the process and result that occurred within him/her. Thus, the teachers should be able to recognize and assist the learning process in accordance with the needs of their students.

In association with the development of Information and Communication Technology (ICT), teachers and students should be able to be equal to and utilize the advance of it. Teachers should be able to exploit or utilize the ICT-based media in the learning process. With the rapid development of ICT, there has been a shift in views on learning in and outside the classroom.

In the field of education, especially in learning, the utilization of ICT in Indonesia is less. Though there are numerous education application programs such as traded learning software, yet the suitability of materials, technology devices used, instructional strategies, and languages are still the obstacles. Thus, the development of computer usage in mathematics, which is designed in accordance with the requirement, is expected to be much help to enhance students' mastery of mathematics.

Technology devices can be used to help students investigate various mathematical phenomenon. ICT can also assist students in learning mathematics. For example, through a computer students can check more examples or formats that seen visually and observed directly, so that students can easily formulate and explore mathematical conjectures. Dunham and Dick stated that with the proper use of computer technology, students are expected to learn mathematics in more meaningful and profound ways [4]. Furthermore, Dubinsky and Tall stated that computers can also give much-needed meaning to mathematical concepts that students may feel are 'not of the physical world" but in the mind or in some ideal world [3].

Some of the advantages gained through the use of computers as a medium of learning are able to present graphs and pictures as a visual form that can be observed and studied by students in the conceptualization and mathematical modeling. Dubinsky and Tall stated that not only computer construct can be used to perform processes represented by the abstract idea, but it can itself be also manipulated. Also, by using computer students even able to see the visual graphic presentation of a very

difficult equation or mathematical model that cannot be described manually [3]. Therefore, Bitter and Hatfield stated that it is reasonable if educational researchers stated that computers can potentially be functionalized to improve learning quality, especially in mathematics [1].

In utilizing the advantage of ICT, it needs to consider diversity of student's abilities as well as wider opportunities for society to obtain education. To meet the children necessities with various abilities, teachers should try to serve all children well. To meet these expectations, teacher's role is certainly not easy. Ruseffendi stated that the more heterogeneous the students, the more difficult to teach [10]. Therefore, teachers need extra effort to serve students with various abilities. One particular way of teaching mathematics may be understood by some students, but most of the others are probably not. Such conditions encourage the efforts to design an acceptable learning model, for example through ICT-based learning model.

In relation with efforts to design innovative learning, today the utilization of ICT in learning has begun. One of them is known by the term of *e-learning*. Researches related to the utilization of e-learning in mathematics have been done at the college level. As for high-school level, it is still limited. Besides the advantages of e-learning, there are also disadvantages in the view of points of teachers—teachers are required to be ready to serve or to answer questions to students any time.

The advantages, the disadvantages and also limited utilization of ICT in learning mathematics in school, encourage researchers to develop e-learning base on animation content and implement it in teaching and learning mathematics to improve mathematical connections abilities of high school students.

## 2. Research Questions

The research conducted is designed to answer the following questions:

1. How can we develop e-learning based on animation contents which could improve the students' mathematical connections abilities?
2. How far is the improvement of students' mathematical connection after e-learning which is based on animation content is implemented in teaching learning process?

## 3. Aim of The Research

This research includes two major areas, namely developing e-learning based on animation content and studying towards the students achievement especially in mathematical connection abilities.

## 3. Hypothesis

Based on the described issues, the hypotheses, namely: E-learning based on animation content can improve mathematical connections abilities of students than those with conventional learning

## 4. Theoretical Foundation

### 1) E-learning based on animation content

In accordance with the rapid development of Information and Communication Technology (ICT), the need for a concept and a mechanism of learning and teaching (education) based on ICT becomes inevitable. The concept known as e-learning has brought influence to the process of transforming conventional education into digital, both in content and system. The present concept of e-learning has been widely accepted by the world community, proven by the proliferation of e-learning in educational institutions (schools, training and universities) and industry (Cisco Systems, IBM, HP, Oracle, etc.). John Chambers who is the CEO of Cisco Systems company said that for the next era, the application in education will be a "killer application" which is very influential. The Department of Commerce and even the U.S. Department of Education has joined to declare the Vision of 2020 which related to the concept of education based on Information Technology (e-learning) [13]. This section will focus the discussion on the application of e-learning and its development. How the application of e-learning should be developed with a balance between user needs and desires of developers. Explanation will start from the definition of e-learning, why do we need e-learning, e-learning history, some analysis of the failure of e-learning and e-learning development strategy.

The term e-learning contains a very broad understanding, so a lot of experts elaborate on the definition of e-learning from various perspectives. One acceptable definition is stated by Hartley: e-learning is a type of teaching and learning which enables to deliver teaching materials to students by using the internet, intranet or other computer network media [5]. LearnFrame.Com in Glossary of e-learning terms [6] explained a broader definition; e-learning is the educational system that uses electronic applications to support learning and teaching with the Internet media, computer network, or standalone computer.

The system of e-learning used in this study was developed by using a Moodle program based on Open Source. This e-

learning program is developed by researchers for the purposes of this study. Teaching materials appeared in e-learning have animations (*. swf). Thus, with the existence of interactive teaching materials, students can interact with e-learning systems independently, including doing exercises interactively. E-learning used by the previous researchers is web-based only; which does not display animation and interactive teaching materials. But, in this e-learning animation or flash content material was made by the researcher were added by several sources obtained from several sites on the internet, such as from www.e-dukasia.net.

### 2) Mathematical Connection

The ability of mathematical connections belong to the higher-order of thinking ability. The mathematical connection means capacity above given information, with a critical attitude to evaluate something and has a metacognitive awareness and problem-solving ability. Marzano, et all., stated that metacognition is the process by which individuals utilize their cognition in understanding him/herself, thinking processes, and control of thinking processes [8]. Suryadi stated too that metacognitive is important since someone's knowledge about the cognitive processes can guide him/herself in choosing a strategy to improve further cognitive performance [12].

Furthermore, Marzano in [9] suggested that the higher-order of thinking included aspects of organizing, analyzing, building (generating), investigating and evaluating. Meanwhile, Ibrahim and Nur gave an explanation of the characteristics of the higher-order thinking, such as: non algorithmic, which means an array of action that is not fully established earlier, tends to complex, often produces a lot of solutions, involves consideration and interpretation, as well as higher mental activity [7].

Moreover Web and Coxford explained that the higher-order of thinking involves understanding the mathematical ideas in a more depth, by examining the data and exploring the idea of the lines, making conjectures, analogies and generalizations, logical reasoning, problem solving, communicating in mathematics, and relating mathematical ideas with other intellectual activities [14].

The theory of the higher-order of thinking focuses on the developmental approach or definitional approach. Developmental approach assume that there is a way of thinking from lower forms into higher forms, and students must have the low-level of thinking first before reaching the higher level one. Although the definitional approach assume that all students can engage in the higher-order of thinking, without going through the stages of students' thinking abilities.

The linkage between the higher-order of thinking with mathematics described by Romberg in Chair stated that some aspects of the higher-order of thinking, are mathematical problem solving, mathematical communication, mathematical reasoning, and mathematical connections [2].

Mathematical connections or connections in mathematics study the students' understanding of connecting the mathematical ideas that will facilitate the ability to formulate and verify conjectures deductively between topics. The mathematical concept and procedure developed which are newly can be applied to solve the other problems in mathematics and other disciplines.

Sumarmo [11] describe some of the indicators in mathematical connections:

a) Finding the relationship of the various representations of concepts and procedures,
b) Understanding the relationship between mathematical topics,
c) Using mathematics in other areas of study or daily life,
d) Understanding the representation of equivalent concept or similar procedure,
e) Finding the connection between one procedure to another in an equivalent representation.
f) Using connections among mathematical topics and between mathematics with another subject.

## 5. Method

This research is intended to develop e-learning based on animation content for improving student mathematical connection abilities. The method used are Research and Development (R&D). The steps taken in the process of this research leads to a cycle based on the findings of research studies and then develop a product. Product development based on preliminary findings of this research was tested in a situation and then revisions are made from the test results until finally obtained a product.

The product itself is e-learning based on animation content. The procedure of this study uses the techniques of research and development with the following steps: (i) development of models, which are: preliminary study, planning, content design and writing, material development, and field testing and revision of the model. (ii) analysis of the e-learning model impact on the student mathematical connection abilities.

To find out the students mathematical connection abilities an experiment with pretest-posttest control group design was used to the student. One class was given a treatment with e-learning based on animation content and the other with conventional treatment.

The design of the study is: $O_1$ $X_1$ $O_2$
$O_1$ $O_2$

Note:
$O_1$: Pretest mathematical connection.
$O_2$: Posttest mathematical connection
$X_1$: Mathematics Learning with e-learning based on animation content

Sample subjects of this study were the eleventh grade students from high schools in Bandung, Indonesia, which were set purposefully based on the completeness of ICT laboratory facilities. The students divide into two classrooms which were randomly assigned—one class for e-learning based on animation content and one class for conventional learning.

## 6. Findings

### a. Development of E-Learning Based on Animation Content

According to the procedure of this study in developing e-learning based on animation content it was developed with the following steps according to Backroad Connections Pty Ltd 2003: (1) preliminary study, (2) planning, (3) Content design and writing, (4) Material development, and (5) Testing and final checking [15]. Therefore, here are the result:

(1) Preliminary study

In this phase we analyzed the requirement of development e-learning based on animation content, including: students needed, software and hardware requirement, animation content, etc. Based on the results, it obtain needs an analysis which conducted the following matters:

a) The e-learning materials requirement that can display animated form.
b) Software for developing e-learning using Moddles version 2.0.
c) The content shape created by using Macromedia Flash animation and partly derived from www.e-dukasia.net

(2) Planning

The planning for the development of e-learning based on animations content includes: planning the e-learning menu, animation contents, quizzes, exercises, tasks, and evaluation. All of which were adapted to target students who will be given e-learning.

(3) Content design and writing

There are several steps that have been done in this phase includes:

a) Applying an effective instructional design.
b) Deciding what should be presented on screen and what can be downloaded/printed.
c) Stating on time allocations for each learning activity according to the content and the learning objectives.
d) Defining and providing the learning support needs of the students, and also for teachers. [15]

(4) Materials development

This phase includes: user guides, implementation guides, etc.

(5) Testing and final checking

This phase requires steps as the following:
a) Knowing what standards should be aimed for
b) Establishing means by which to measure or test that standards and usability objective have been achieved. Considering when to measure, and how information from this will feed back into the development process to achieve best outcomes most efficiently. [15]

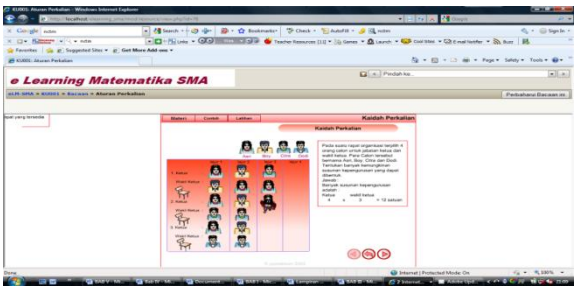


Figure 1. An Example of e-learning based on animation content

### b. Research Result in Implementation of E-Learning Based on Animation Content

After the e-learning have been developed continued by implementes it to the students

The research results are as follows:

Table 1. Average result of Pre and Post Test of Mathematical Connection Abilities

| Class | Average result of test | |
|---|---|---|
| | Pre test | Posttest |
| e-learning | 65 | 72,9 |
| convensional | 64 | 71,3 |

Table 2. t-test of Mathematical Connection Abilities

| Mean | SD | Std. Error Mean | T | df | Sig |
|---|---|---|---|---|---|
| 18.60 | 9.39 | 2.97 | 6.26 | 20 | .00 |

Based on the total score of mathematical ability presented in Table 1 and Table 2., the results obtained were that the top most mathematical ability was the mathematical connection abilities of students with e-learning. From the results it can be said that e-learning increased students' mathematical connection abilities rather than with conventional one.

## 7. Conclusions

From the results of the research and discussion, it can be concluded that:

1. E-Learning based on animation content can be developed according to the development of systems models, which are: preliminary study, planning, field testing and revision of the model.
2. Students with e-learning have a better result in its mathematical connection ability than students with conventional learning.

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