International Journal of Trends in Mathematics Education Research
Vol. 5, No. 4 (2022), pp. 429-434
ISSN 2621-8488 (online)
DOI: https://doi.org/10.33122/ijtmer.v5i4.167

SAINTIS publishing

Research Article

# Developing e-learning based on animation content to improve students' mathematical connection abilities

**Rusdyi Habsyi, Rusmin R. M. Saleh**✉

STKIP Kie Raha Ternate, Indonesia
✉Corresponding Author: rusminrmsaleh@gmail.com | Phone: +6282194429497

*Received: 16 September 2022* *Revised: 27 October 2022* *Accepted: 25 November 2022* *Available online: 30 December 2022*

## ABSTRACT

Mathematical connection capabilities are part of an interconnected network of interconnected knowledge packages of interconnected knowledge packages of knowledge packages consisting of key concepts for understanding and developing relationships between mathematical ideas, concepts, and procedures. 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 Moodle, while the animation content was developed using macromedia flash. To get the student mathematical connection abilities, pretest and posttest 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. From the posttest results show that the total score of mathematical connection abilities presented shows that the average posttest of mathematical connection abilities is 72.9 e-learning based on animation content, this shows that e-learning based on animation content can improve mathematical connection skills students with e-learning.

**Keywords:** animation; contents; e-learning; mathematical; connection;

## 1. INTRODUCTION

Mathematical connection capabilities are part of an interconnected network of interconnected knowledge packages of interconnected knowledge packages of knowledge packages consisting of key concepts for understanding and developing relationships between mathematical ideas, concepts, and procedures (Diana et al. al., 2020). The ability of students to make mathematical connections is one of the important points that must be achieved in the learning process, because by knowing the interrelationships between mathematical concepts, students will find it easier to understand mathematics itself and open up opportunities for students to be able to develop their abilities towards mathematics (Siregar et al., 2021).

The National Council of Teachers of Mathematics (NTMC) states that mathematical connection is one of the basic abilities that must be possessed by students (Latif, 2017). Connection is a relationship or connection. Connections in mathematics are a link between mathematical concepts both from within (internally) and from outside (externally) (Nunes et al., 2012). When viewed from an internal perspective, the mathematical connection is a relationship related to the concepts that exist in mathematics, while from an external perspective the connection is very closely related to other fields of science in everyday life (Hazrati et al., 2020). Learning mathematics is a subject related to concepts (Dinni & Isnarto, 2018; Nunes et al., 2012). Concepts are abstract ideas that can classify and classify a set of objects (Ningsih et al., 2019). Concepts in learning mathematics are interrelated with one another, we can see when studying a mathematical concepts it is necessary to pay attention to other concepts from previous mathematics learning. This is what is called the ability of mathematical connections, namely the ability of students to connect a concept with other concepts (Rohendi, 2012).

According to NCTM, there are two general types of mathematical connections, namely modeling connections and mathematical connections (Ariawan & Nufus, 2018). Modeling connections are relationships between problem situations that arise in the real world or in other disciplines and their mathematical representations, while mathematical connections are relationships between two equivalent representations, and between the completion process of each representation. The two connections are illustrated as shown in **Figure 1** (Siagian, 2016). The ability to connect mathematics has the following indicators: a) Finding the relationship between various representations of concepts and procedures, b) Understanding the relationship between mathematical topics, c) Using mathematics in other fields of study or everyday life, d) Understanding representations of equivalent concepts or similar procedures, e) Finding the relationship between one procedure and another in an equivalent representation, f) Using the relationship between mathematics topics and between mathematics and other subjects (Latipah & Afriansyah, 2018).

Mathematical connection abilities are really needed by students because mathematics is a unified whole, where one concept is closely related to other concepts, or in other words that learning certain concepts in mathematics requires prerequisites from other concepts (Ariawan & Nufus, 2018); Suhandri et al., 2017). Mathematical connection ability holds very important importance in improving students' understanding in learning mathematics (Azzatia et al., 2019). The purpose of mathematical connection ability is so that students can view mathematics as a unified whole, understand mathematical ideas in order to understand further mathematical ideas, investigate and describe the results of the problems they investigate, and use their minds and create models to solve problems both both in mathematics and in other disciplines.

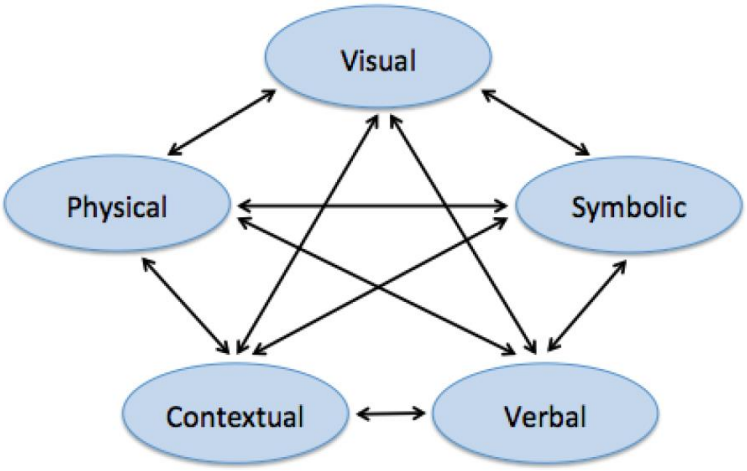


**Figure 1**. Types of Mathematical Connection

In the 2019 research on mathematical connection skills, there are still many students who do not yet have mathematical connection abilities. The results of his research have shown that students who have mathematical connection skills are still low (Septian & Komala, 2019). In addition, other research results in 2021, show that the average mathematical connection ability of students in secondary schools is still relatively low, the average score is still less than 60 at a maximum score of 100, which is around 22.2% for mathematical connections between topics, 44% for mathematical connections between other fields of study, and 67.3% for mathematical connections in real life (Hasbi et al., 2021).

One of the media that can be used to improve the ability of mathematical connections is to use electronic technology in the form of e-learning based on animation media (Fani & Effendi, 2021). Electronic technology can be used to assist students in understanding visual representations of mathematical ideas, also make it easier for students to organize and analyze data, and help students to calculate quickly and accurately. One technology that can be used is a computer (Rusli, 2017). Computers can be used as a tool to complement the excellence of mathematical thinking in various ways (Jalinus & Alim, 2019). Based on the advantages of the role of technological advances, in facing the challenges of the 21st century it is necessary to develop various strategies, learning models, and the use of electronic technology-based learning media in such a way as to create a pleasant atmosphere. both for students and teachers (Maryeni et al., 2020).

Technological tools can be used to help students investigate various mathematical phenomena. ICT can also help students in learning mathematics (Hasin & M Nasir, 2021). For example, through computers students can check more examples or formats that are seen visually and observed directly, so students can easily formulate and explore mathematical conjectures. Using the right computer technology, students are expected to be able to learn mathematics in a more meaningful and in-depth way. Furthermore, it is argued that computers can also provide much-needed meaning to mathematical concepts that students may perceive 'not from the physical world' but in the mind or in an ideal world (Perienen, 2020). With the rapid development of ICT, there has been a shift in views towards learning inside and outside the classroom (Wibowo, 2018). In the field of education, especially in learning, the use of ICT in Indonesia is still lacking. Although many educational application programs such as learning software are traded, the suitability of the material, the technology used, learning strategies, and language are still obstacles (Wibowo & Pratiwi, 2018). Thus, the development of the use of computers in mathematics, which is designed according to needs, is expected to help a lot in increasing students' mastery of mathematics.

In accordance with the rapid development of Information and Communication Technology (ICT), the need for ICT-based concepts and mechanisms for teaching and learning (education) has become a necessity. One of the concepts known as e-learning has had an influence on the process of transforming conventional education into digital, both in content and system (Ahn & Edwin, 2018). The term e-learning contains a very broad meaning, so many experts describe the definition of e-learning from various points of view. E-learning is a type of teaching and learning that allows the delivery of teaching materials to students using the internet, intranet or other computer network media (Panyajamorn et al., 2018). The definition that explains that e-learning is an educational system that uses electronic applications to support learning and teaching with internet media, computer networks, or standalone computers (Moreno-Guerrero et al., 2020; Yaniawati et al., 2020). The learning program was developed by the researcher for the purposes of this research. The teaching materials displayed in e-learning have animations. Thus, with interactive teaching materials, students can interact with the e-learning system independently, including doing exercises interactively.

## 2. RESEARCH METHOD

This study aims to develop e-learning based on animation content to improve students' mathematical connection skills. According to this research procedure, in developing learning based on animation content, it was developed with the following steps: (1) preliminary study, (2) planning, (3) content design and writing, (4) material development, and (5) final testing and examination (Bauer et al., 2021; Qammach & Al-Sharifi, 2021). The steps taken in this research process lead to a cycle based on the findings of research studies and then develop a product. Product development based on the initial findings of this study was tested in a situation and then revised from the test results until finally a product was obtained. The product itself is an e-learning based on animated content. This research procedure uses research and development techniques with the following steps: (i) model development, namely: preliminary study, planning, content design and writing, material development, as well as field testing and model revision. (ii) analysis of the effect of the e-learning model on students' mathematical connection abilities. To determine students' mathematical connection abilities, experimental designs using non-experimental designs were used as shown in **Figure 3** (Suparman et al., 2020).

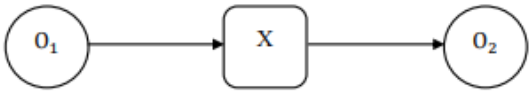


**Figure 2**. Non-experimental pretest/posttest design

The subjects in this study were students of class XI SMA Muhammadiyah Ternate. Collecting data by using pre-test and post-test questions. The data were analyzed by t-test and it was found that animated content-based e-learning not only had a significant effect on mathematical connection skills but also improved students' mathematical connection skills much better than the conventional approach.

## 3. RESULTS AND DISCUSSION

### 3.1 Results

#### *a.* Animated Content-Based E-Learning Development

According to this research procedure, 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) Final testing and inspection (Bauer et al., 2021; Qammach & Al-Sharifi, 2021), with the following results.

##### *1. Preliminary Research*

At this stage, an analysis of the needs for developing animated content-based e-learning is carried out, including: student needs, software and hardware requirements, animated content, etc. Based on these results, a needs analysis was obtained which did the following:

a) The need for e-learning materials that can display the form of animation.
b) Software to develop e-learning using Moodles version 2.0.
c) The form of content is created using Macromedia Flash animation.

##### *2. Planning*

Animated content-based e-learning development planning includes: e-learning menu planning, animated content, quizzes, exercises, assignments, and evaluations. All of them are adjusted to the target students who will be given e-learning.

##### *3. Contents Design and Writing*

There are several steps that have been taken in this phase, including:

a) Applying an effective learning design.
b) Deciding what should be shown on the screen and what can be downloaded/printed.
c) State the time allocation for each learning activity in accordance with the content and objectives of learning.
d) Define and provide learning support needs for students, as well as for teachers.

In this stage, the design of an example of e-learning based on animated content is shown in **Figure 3.**


**Figure 3**. An Example of e-learning based on Animation Contents

***4. Material Development***

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

***5. Final Testing and Checking***

a) Knowing what standards to aim for.

b) Establish ways to measure or test that the standards and usability objectives have been achieved. Consider when to measure, and how information from this will feed back into the development process to achieve the best results most efficiently.

### *b.* Research Results on the Implementation of Animated Content-Based E-Learning

After e-learning is developed, it is continued by implementing it to students. The results of the study are seen in **Table 1.**

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

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

After the pretest and posttest data are normally distributed, a statistical test will be carried out using a dependent t test, namely one sample with two pretest and posttest data with one-sided test criteria, as seen in Table 2.

**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 |

## 3.2 Discussion

The development of content-based e-learning in this study used the following steps, namely 1) needs analysis, 2) planning, 3) content design and writing, 4) material development, and 5) final testing and examination. At the stage of needs analysis regarding the development of animated content-based e-learning which includes students' needs for software and hardware needs, animated content, etc. From the results of the needs analysis, it is obtained that the material needs that can be displayed in the form of animation, software for developing e-learning using Moodles version 2.0, the form of animation content created using Macromedia Flash. At the planning stage of developing animated content-based e-learning includes: e-learning planning menus, animated content, quizzes, exercises, assignments, and evaluations. Everything is adjusted to the target students who will be given e-learning. At the content design and writing stage, it is done by implementing a learning design, deciding what should be displayed on the screen and what can be downloaded/printed, stating the time allocation for each learning activity according to the content and learning objectives, and defining and providing learning support needs for students, also for teachers. At the material development stage, what is done is to create a user guide and an e-learning implementation guide based on animated content. The last stage is the testing and final inspection stage, which is to find out what standards you want to achieve, determine how to measure or test that the standards and usability goals have been achieved. Based on the last stage of testing and examination, it can be seen that the total score of mathematical connection abilities is presented in **Table 1** and **Table 2**, the results show that the average posttest of mathematical connection abilities is 72.9 using e-learning based on animation content, this shows that e-learning based on animation content can improve mathematical connection abilities, as shown in **Figure 4.** From these results it can be said that e-learning improves students' mathematical connection abilities compared to conventional ones

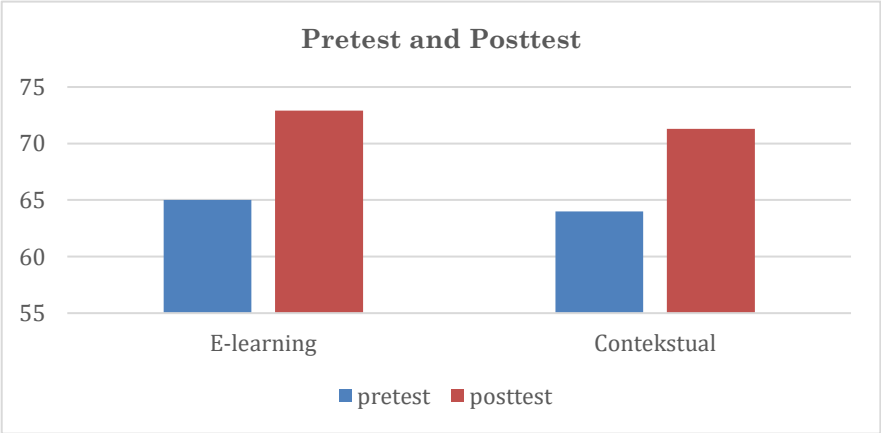


**Figure 4**. Pretest and Posttest Results

## 4. CONCLUSION

Based on the results of the research and discussion, it can be concluded that e-learning based on animation content can be developed according to the system model development, namely: preliminary studies, planning, field testing and model revision. From the posttest results show that the total score of mathematical connection abilities presented shows that the average posttest of mathematical connection abilities is 72.9 using e-learning based on animation content, this shows that e-learning based on animation content can improve mathematical connection skills students with e-learning.

## ACKNOWLEDGEMENTS

The current preparing this manuscript, we are fully aware that the completion of this article is inseparable from support, enthusiasm, and guidance from various parties, both moral and material. Because of this, we would like to express our gratitude to the supervisors, postgraduate lecturers, principals and teachers of the partner SMA Muhammadiyah Ternate, as well as friends from the STKIP Kie Raha Ternate.

## AUTHOR'S CONTRIBUTIONS

The authors discussed the results and contributed to from the start to final manuscript.

## CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

## REFERENCES

Ahn, J. Y., & Edwin, A. (2018). An e-learning model for teaching mathematics on an open source learning platform. *International Review of Research in Open and Distance Learning*, *19*(5), 256–267. https://doi.org/10.19173/irrodl.v19i5.3733

Ariawan, R., & Nufus, H. (2018). Profil Kemampuan Koneksi Matematis Mahasiswa Dalam Menyelesaikan Masalah Pada Mata Kuliah Kalkulus I Ditinjau Berdasarkan Level Kemampuan Akademik. *Jurnal Prinsip Pendidikan Matematika*, *1*(1), 16–22. https://doi.org/10.33578/prinsip.v1i1.15

Azzatia, S. F., Pascasarjana, F., Ahmad, U., Yogyakarta, D., Ahmad, U., & Yogyakarta, D. (2019). Design of Mathematic Learning Module Based on Ethnomathematicsusing Inquiry Method To Improve Mathematical Connection Ability Students of Class VII. *12*, 10–17.

Diana, N., Suryadi, D., & Dahlan, J. A. (2020). Analysis of students' mathematical connection abilities in solving problem of circle material: Transposition study. *Journal for the Education of Gifted Young Scientists*, *8*(2), 829–842. https://doi.org/10.17478/JEGYS.689673

Dinni, H. N., & Isnarto. (2018). Mathematical Connection Abilities and Self-Esteem of Students on Model-Eliciting Activities Learning with a Realistic Approach. *Unnes Journal of Mathematics Education Research*, *7*(2), 161–166.

Fani, A. A. D., & Effendi, K. N. S. (2021). Kemampuan koneksi matematis siswa ditinjau dari kecemasan belajar pada siswa smp pada materi lingkaran. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *4*(1), 137–148. https://doi.org/10.22460/jpmi.v4i1.137-148

Hasbi, M., Lukito, A., & Sulaiman, R. (2021). Pengembangan Pembelajaran Matematika Siswa SMP: Koneksi Matematis Pada Realistik Mathematics Education. *Infinity: Jurnal Matematika Dan Aplikasinya*, *1*(2), 1–11. https://doi.org/10.30605/27458326-47

Hasin, I., & M Nasir, M. K. (2021). The effectiveness of the use of Information and Communication Technology (ICT) in rural secondary schools in Malaysia. *Journal of Education and E-Learning Research*, *8*(1), 59–64. https://doi.org/10.20448/JOURNAL.509.2021.81.59.64

Hazrati, K., Minarni, A., & Rajagukguk, W. (2020). Differences in Mathematic Connection Abilities and Self-Efficacy between Students Given Approaches Realistic Mathematics with the Approach Inquiry at Senior High School 2 Tanjung Morawa. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, *3*(3), 1489–1500. https://doi.org/10.33258/birle.v3i3.1222

Jalinus, & Alim, J. A. (2019). Quality Review of Computer Based Interactive Mathematics Learning Media on Geometry Topics in Flat Fields for Elementary Students. *Proceedings of the UR International Conference on Educational Sciences*, 397–407.

Latif, S. (2017). Mathematical Connection Ability in Solving Mathematics Problem Based on Initial Abilities of Students At Smpn 10 Bulukumba. *Jurnal Daya Matematis*, *4*(2), 207. https://doi.org/10.26858/jds.v4i2.2899

Latipah, E. D. P., & Afriansyah, E. A. (2018). Analisis Kemampuan Koneksi Matematis Siswa Menggunakan Pendekatan Pembelajaran CTL dan RME. *Matematika*, *17*(1), 1–12. https://doi.org/10.29313/jmtm.v17i1.3691

Maryeni, L., Siregar, S. N., Roza, Y., & Jalinus, J. (2020). Development of Computer-Based Learning Media Using Mind Map for Learning Mathematics in Topics of Rectangle and Triangle at Secondary School. 2019 (July 2019), 73–84. https://doi.org/10.24071/seadr.2019.11

Ningsih, A. F., Ariyanto, L., & Dwijayanti, I. (2019). Profile of Student Mathematical Connection Abilities in Understanding Mathematical Concepts in Terms of Gender. *Jurnal Daya Matematis*, *6*(3), 296. https://doi.org/10.26858/jds.v6i3.8530

Nunes, T., Bryant, P., Barros, R., & Sylva, K. (2012). The relative importance of two different mathematical abilities to mathematical achievement. *British Journal of Educational Psychology*, *82*(1), 136–156. https://doi.org/10.1111/j.2044-8279.2011.02033.x

Perienen, A. (2020). Frameworks for ICT Integration in Mathematics Education - A Teacher's Perspective. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(6). https://doi.org/10.29333/ejmste/7803

Rohendi, D. (2012). Developing E-Learning Based on Animation Content for Improving Mathematical Connection Abilities in High School Students. *9*(4), 1–5.

Rusli, M. (2017). Computer-Based Learning and Learning Style *Department of Information System Department of Computer System*. *109*, 177–190.

Septian, A., & Komala, E. (2019). Kemampuan Koneksi Matematik Dan Motivasi Belajar Siswa Dengan Mengunakan Model Problem-Based Learning (Pbl) Berbantuan Geogebra Di Smp. *Prisma*, *8*(1), 1. https://doi.org/10.35194/jp.v8i1.438

Siagian, M. D. (2016). Kemampuan koneksi matematik dalam pembelajaran matematika. *MES: Journal of Matematics Education and Science2*, *2*(1), 58–67.

Siregar, A., Sinaga, B., & Syahputra, H. (2021). Development of Mandailing Culture-Based Learning Devices with an Open-Ended Approach to Improve Students 'Mathematic Connection and Self-Efficiency Abilities SMPN 2 Batangtoru. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, *4*(1), 226–238. https://doi.org/10.33258/birle.v4i1.1580

Suhandri, S., Nufus, H., & Nurdin, E. (2017). Profil Kemampuan Koneksi Matematis Mahasiswa dalam Menyelesaikan Masalah Matematika Berdasarkan Level Kemampuan Akademik. *Jurnal Analisa*, *3*(2), 115–129. https://doi.org/10.15575/ja.v3i2.2012

Sulistyaningsih, D., Purnomo, P., & Aziz, A. (2018). Development of Learning Design for Mathematics Manipulatives Learning based on E-learning and Character Building. *International Electronic Journal of Mathematics Education*, *14*(1), 197–205. https://doi.org/10.29333/iejme/3996