



# Assessing moodle-assisted e-learning for students' concept understanding and critical thinking skills in algebra

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## Abstract

Conceptual understanding and critical thinking skills are necessary for all students to help them in their learning process. This research aims to determine the effect of Moodle-assisted e-learning on (1) conceptual understanding, (2) critical thinking skills, and (3) conceptual understanding and critical thinking skills combined. This research employed a quasi-experimental design with random cluster sampling was used as the sampling technique. An algebra written test was used to collect research data. Furthermore, the researchers performed the normality test, homogeneity test, and MANOVA analysis to analyze the data. The researchers discovered that Moodle-assisted e-learning influenced students' conceptual understanding, critical thinking skills, and conceptual understanding and critical thinking skills.

## INTRODUCTION

Education plays a critical role in developing capable and ethical human beings (Hanifah et al., 2019). It is performed by educators or lecturers to impart knowledge by organizing and developing a learning system that incorporates a variety of methods to enable students to carry out learning activities optimally (Kiron, 2017). Science is critical to improving people's quality of life. Someone can enhance their individual quality through a learning process aimed at developing abilities (Wahyuni & Sugiharta, 2019).

The learning objectives have not been achieved optimally since students are struggling with mathematics. Mathematics is frequently categorized as a general education subject taught at all levels of education (Barakabitze et al., 2019; Gabriel et al., 2018; Wahyuni & Sugiharta, 2019). However, basic mathematics lessons are not given a separate portion in the Al-Ahwal Al-Syahksiyah study program, which causes students to struggle with astrology. Astrology is the foundation in analyzing time (Mayer, 2020; Sukdaven & Sodeke, 2019) and a method of determining times of worship and the direction of Qibla. Astrology can be used to determine the elevation of a location, the area of a river, the seasons, and the distribution of zakat, which further confirm the necessity of basic mathematics lessons at Al-Ahwal Al-Syahksiyah (Levy-Eichel, 2017). It is critical as a priority for students to acquire knowledge, conceptual understanding, skills, and abilities in the fields of technology, media, and information (Huda, Firmansyah, et al., 2019). Thus, it is necessary to grasp the concepts of understanding and critical thinking skills in astronomy to comprehend and make reliable decisions during the learning process.

How to cite

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The conceptual understanding is a foundational ability that students must possess to develop other abilities, such as problem-solving, critical thinking, communication, and mathematical representation. Thus, it has a significant impact on the development of advanced mathematical abilities (Romadon & Mahmudi, 2019). The ability to restate a concept, group objects according to their properties, mention examples and not examples of concepts, represent concepts in the form of pictures, graphs, tables, and others, and examine requirements are all indicators of conceptual understanding. Also, it is beneficial in explaining a concept, selecting the appropriate procedure, and applying the concept to real-world problems (Amalia & Puwaningsih, 2020).

The conceptual understanding ability has served as a springboard for developing additional mathematical abilities, including critical thinking abilities. Critical thinking can be a capacity for self-reflection and reasoning in decision-making (Nuryanti et al., 2018). Critical thinking is a way of approaching a subject, content, or problem that can foster the skills (Kurniati et al., 2015; Shanta & Wells, 2020). Critical thinking is used to determine correct and incorrect (Mishra & Mehta, 2017; Paul & Elder, 2019). Thus, critical thinking skills must be taught to students to be capable of deciding on an idea in the future (Sulton Nawawi, 2018).

The skills of the third-semester students in the academic year of 2019/2020 at Al-Ahwal Al-Syahkshiyah Study Program at UIN Raden Intan Lampung in concept understanding and critical thinking were below the criteria of minimum mastery of algebra, which was 75. The students struggled to apply concepts and were unable to decide or analyze answers. The lack of algebraic logic and precision in students' answers supports this statement (Tejeda & Gallardo, 2017). The lack of mastery of these sub-competencies can be associated with basic mathematical activities in learning algebra (Niss et al., 2017). Therefore algebra is important in teaching and learning. Algebra is a branch of mathematics taught at the beginning of the first year of secondary school to higher education (Wheeler, 2018). This knowledge will serve as the foundation for Pre-calculus. Algebraic concepts serve as foundations that can act like either bricks or holes, mysteriously assisting or impeding students' learning. However, factors such as low variety, non-interactive, and monotonous learnings caused students unable to absorb the information properly. Another factor is that there are no fundamental mathematics courses in the study program.

Further research is necessary to enhance students' conceptual understanding and critical thinking skills. Proper education can influence one's success in school. Education as a process of learning requires a model of learning that is superior to previous learning. The use of technology in education can result in educational innovations that encourage students to be more active, creative, and innovative (Hanifah et al., 2019). Optimal learning presented by advances in information and communication technology (ICT) will profoundly impact all aspects of education. Technology can influence learning; for example, e-learning models as one of the teaching options (Pham et al., 2019).

E-learning is a form of technology-assisted learning that is important for students participating in the distance learning process (Novi Yanti & Sugiharta, 2019). E-learning requires an internet connection, which necessitates web applications and computing equipment to facilitate the teaching and learning process. Students and lecturers alike can benefit from e-learning, which can make learning more effective and efficient. Additionally, it can benefit students by providing online assignments, answers, and discussion boards. It enhances the teaching and learning process, provides access to educational curricula, and

expands educational opportunities (Yakubu & Dasuki, 2018). E-learning refers to a technology platform that enables students to learn at their own pace and on their schedule. E-learning is a contemporary form of education in which all interactions between students and lecturers take place online via internet-assisted media (Solangi et al., 2018).

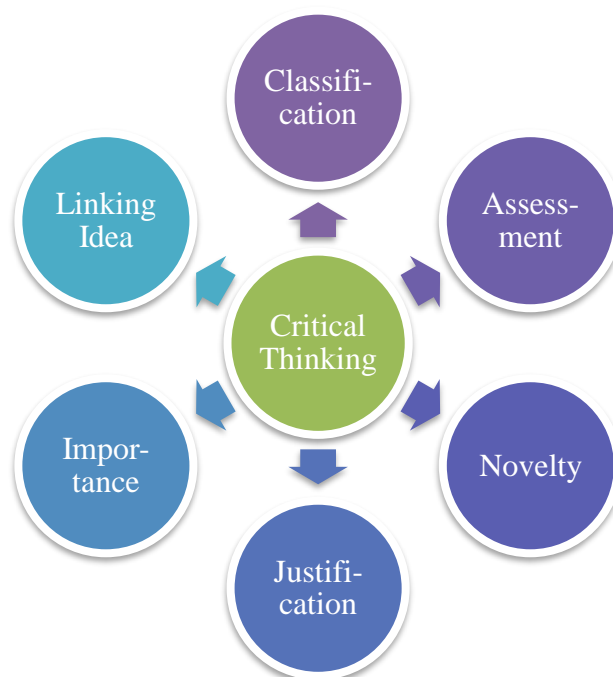
Previous studies indicate that e-learning implementation resulted in higher achievement levels than learning via PowerPoint (Arifin & Herman, 2018). Other research indicates a positive correlation between self-regulated learning and concept understanding facilitated by Google Classroom and WhatsApp groups (Amalia & Puwaningsih, 2020). E-learning is more effective in promoting learning performance through gender (Gambari et al., 2018). Other studies indicate that critical thinking skills acquired through an e-learning model have a positive and significantly greater impact (Krisparinama et al., 2020). Internet access enables electronic media to provide lectures flexibility (Azizah & Sugiharta, 2018).

According to previous studies, e-learning improves students' conceptual understanding and critical thinking skills. However, previous studies only focus on teaching and learning. The novelty in this research lies in Moodle as an ICT platform to assess critical thinking skills. Therefore, this research assessed students' conceptual understanding and critical thinking skills using Moodle (Learning Management System platform). The effectiveness of the e-learning model will be compared with the conventional model to determine which model is more effective at improving students' concepts understanding and critical thinking skills. The purpose of this study is to determine: 1) The effect of e-learning on students' conceptual understanding ability; 2) The effect of e-learning on students' critical thinking skills; and 3) The effect of e-learning on students' conceptual understanding ability and critical thinking skills.

## **METHODS**

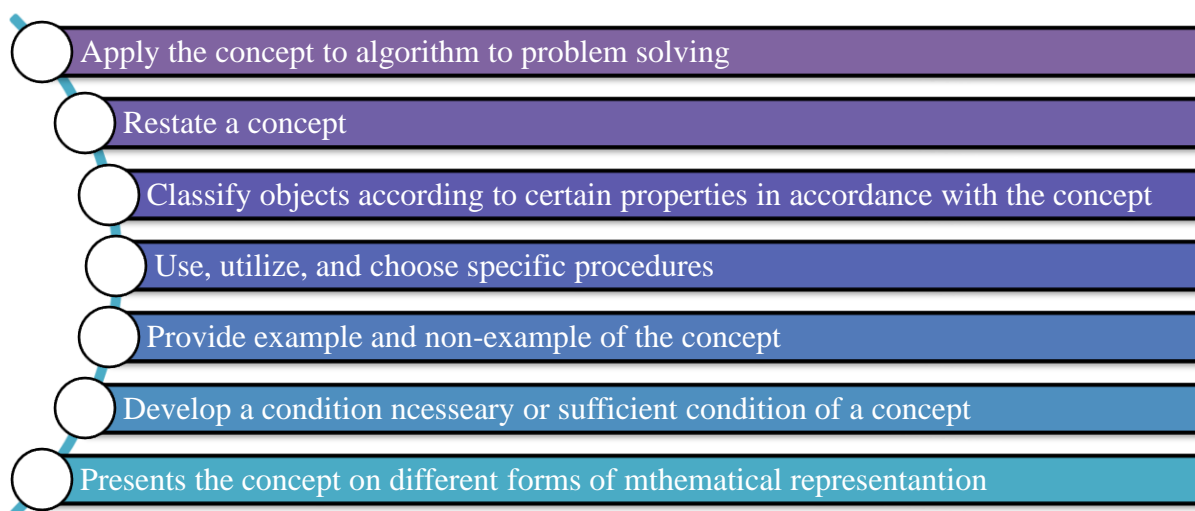
This research employed the quasi-experimental design with pretest and posttest. The research population were third-semester students of the Al-Ahwal Al-Syakhshiyah (Islamic Family Law) Study Program at UIN Raden Intan Lampung in the academic year of 2020/2021. Cluster random sampling was used as the sampling technique, which resulted in two classes. The first class was the control group using WhatsApp-assisted e-learning and the second class was the experimental group using Moodle-assisted e-learning.

The data had been collected using written tests, namely concept understanding test (CUT) and critical thinking test (CTT). The tests were used to assess concepts understanding and critical thinking skills. The test consisted of twelve description questions containing algebra material. The following are indicators of conceptual understanding and critical thinking (Lee et al., 2016; Suherman et al., 2021):



**Figure 1.** The Indicators of Critical Thinking

The concept understanding indicators can be seen in Figure 2 (Komarudin et al., 2021).



**Figure 2.** The Indicators of Concept Understanding

The procedure for instrument testing consisted of validity and reliability tests. The product-moment correlation technique was used to determine the validity, while the Cronbach's Alpha coefficient formula was used to determine the reliability (Rinaldi et al., 2021). Both tests were designed to generate valid and reliable questions. The normality and homogeneity tests were used to analyze the data. The Kolmogorov-Smirnov formula was used to determine the normality, and the Bartlett test was used to determine the homogeneity. Furthermore, the hypothesis test was performed using the multivariate analysis of variance (MANOVA) test and the R program to assess the effect of e-learning on students' concept understanding and critical thinking skills. The hypotheses are as follow:

1.  $H_{0A}$  : There is no influence of Moodle-assisted e-learning on students' concepts understanding ability.

- $H_{1A}$  : There is an influence of Moodle-assisted e-learning on students' concepts understanding ability.
- 2.  $H_{0B}$  : There is no influence of Moodle-assisted e-learning on students' critical thinking skills.
- $H_{1B}$  : There is an influence of Moodle-assisted e-learning on students' critical thinking skills.
- 3.  $H_{0C}$  : There is no influence of Moodle-assisted e-learning on students' concepts understanding ability and critical thinking skills.
- $H_{1C}$  : There is an influence of Moodle-assisted e-learning on students' concepts understanding ability and critical thinking skills.

## RESULTS AND DISCUSSION

The data were analyzed descriptively to express both experimental and control groups. The data consist of range, maximum, minimum, standard deviation, average, and variance.

**Table 1.** The Score of Concepts Understanding Ability

Concepts Understanding Ability	Max	Min	Mean	Mode	Range	St. Dev
Moodle-assisted e-learning	100	49.10	83.33	100	13.00	50.90
WhatsApp-assisted e-learning	100	35.59	60.70	35.90	17.40	64.10

Table 1 shows the students' learning outcomes from different learning platforms on the concept understanding ability. Moodle-assisted e-learning was more influential in increasing students' concepts understanding ability. At the same time, there was no difference in the maximum score. On the other hand, the mean score for Moodle-assisted e-learning was higher than WhatsApp-assisted e-learning. Moodle-assisted e-learning influenced not only students' concepts understanding but also their achievement (Afdarni, 2018). The results of critical thinking tests are presented in Table 2.

**Table 2.** Critical Thinking Ability Score

Critical Thinking Ability	Max	Min	Mean	Mode	Range	St. Dev
Moodle-assisted e-learning	100	33.30	82.24	88	17.40	66.70
WhatsApp-assisted e-learning	100	30.20	69.50	91	20.50	69.80

Table 2 shows that the mean scores were different. To summarize, the mean score of Moodle-assisted e-learning was higher than WhatsApp-assisted e-learning. The standard deviation of Moodle-assisted e-learning was lower than e-learning based on WhatsApp. Concerning the critical thinking skills, the treatments can support achievement for each student (Huang et al., 2017). Before reporting the test, the normality and homogeneity data must be constructed as a testing hypothesis. Table 3 contains data of the normality test, while Table 4 contains data of the homogeneity test.

**Table 3.** The Normality Test on Concept Understanding and Critical Thinking Skills

Classes	Tests	Kolmogorov-Smirnov	Sig.	Results
Experimental	CUT	.096	$p < .05$	Normal
Control		.101		
Experimental	CTT	.157		
Control		.080		

Based on Table 3, the experimental class and control class was normally distributed.

**Table 4.** The Homogeneity Test on Concept Understanding and Critical Thinking Skills

Aspects	Classes	Student Learning Outcomes			sig
		Levene Statistic	df <sub>1</sub>	df <sub>2</sub>	
CUT	Experimental	.916	1	59	$p < .05$
	Control	.471			
CTT	Experimental	.845	1	59	$p < .05$
	Control	.481			

Table 4 shows that both classes were homogeneous in both UCT and CTT. The following steps were conducted to test the hypothesis. The table below contains the results of the MANOVA using the R program.

```
warning message:
In lm.fit(x, y, offset = offset, singular.ok = singular.ok, ...) :
  extra argument 'tets.statistic' will be disregarded
> summary(analysis_manova)
      Df Pillai approx F num Df den Df    Pr(>F)
Perlakuan  1 0.37038   16.766      2    57 1.878e-06 ***
Residuals 58
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> model1<-lm(Concept_Understanding~Treatment, DATAYFZ)
> anova(model1)
Analysis of Variance Table

Response: Concept_Understanding
      Df Sum Sq Mean Sq F value    Pr(>F)
Perlakuan  1 0.7339 0.73390  31.252 6.385e-07 ***
Residuals 58 1.3620 0.02348
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> model2<-lm(Critical_Thinking~Treatment, DATAYFZ)
> anova(model2)
Analysis of Variance Table

Response: Critical_Thinking
      Df Sum Sq Mean Sq F value    Pr(>F)
Perlakuan  1 0.26623 0.266234  7.2651 0.009184 **
Residuals 58 2.12544 0.036645
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> |
```

**Figure 3.** The Results MANOVA Analysis

Figure 3 displays a significant difference in students' concepts understanding ability between the experimental class and the control class. Thus, the treatments in the experimental and control classes can be used to determine the magnitude of the treatments' effects in concepts understanding ability. Since the results of the learning model were  $p < .05$  ( $\text{Pr}(>F)6,385e-07***$ ), it can be concluded that Moodle-assisted e-learning influenced students' concepts understanding ability. Furthermore, the result of critical thinking skills was ( $\text{Pr}(>F) 0,009184**$ ). Therefore, there was an effect on students' critical thinking skills in the experiment class. Moodle-assisted and WhatsApp-assisted e-learning influenced students' concepts understanding and critical thinking skills with a significance level of  $p < .05$ .

E-learning is a type of distance learning via mobile devices, laptops, and computers connected to the internet. The learning is accomplished through discussion of the material provided on Moodle-assisted e-learning of UIN Raden Intan Lampung. This research confirmed previous research by focusing on Moodle-assisted e-learning and emphasizing mathematical critical thinking skills. However, previous research has concentrated exclusively on learning specifically (Arifin & Herman, 2018). This research demonstrated how learning through Moodle-assisted e-learning can aid the development of 21st-century thinking skills, specifically critical thinking.

Related to Moodle-assisted e-learning, a question and answer session was held during the learning process to allow students who did not understand the material to ask questions in the discussion forum. The lessons contained videos to help the students understand the concepts of algebra. Then, the students participated in a face-to-face video meeting to discuss the material and develop their critical thinking skills. Moodle-assisted e-learning influenced students' concepts understanding and critical thinking skills.

Moodle-assisted e-learning is more interactive than e-learning delivered via WhatsApp. It is demonstrated by the bidirectional interaction between students and lecturers. This interaction occurs through videos available on the Moodle platform and interaction or feedback on the tasks and materials presented. The findings corroborated a previous study indicating that Moodle-assisted e-learning can improve students' performance (Mpungose, 2020; Putri et al., 2020; Umek et al., 2015). In comparison to WhatsApp, even though it is delivered via e-learning, no feedback is obtained following the learning conclusion. As a result, one-way learning occurs (Wanner, 2015).

The research findings and the first hypothesis indicated that Moodle-assisted e-learning influenced students' concepts understanding ability because it uses a multitasking platform (Huda, Rinaldi, et al., 2019; Mpungose, 2020) and enables students to freely learn about mathematics (Putra et al., 2020). The findings of this research serve as an alternative for institutions seeking to improve learning performance through existing platforms. However, campaigns promoting the use of the Moodle platform for all educators must be vigorously implemented.

Similarly, the second hypothesis asserts that Moodle-assisted e-learning improves students' critical thinking skills. The difference in algebra scores between the experimental class and control class further prove the findings. Priority was placed on the forms and characteristics of the investigated functions by the students. The findings indicated that they were unaware of the relationship between the graphical form of the functions and the unknowns in the new questions. Through these findings, it is hoped that institutions will always treat students more favourably when it comes to e-learning (Almanthari et al., 2020; Yaniawati et al., 2020). Indeed, algebra education does not have to be conducted face to face because it can also be conducted via e-learning. Then, based on the results of the third hypothesis, this e-learning will help students improve their performance, specifically their concept understanding ability and critical thinking skills. In other words, students' cognitive needs must be met (Andari et al., 2020; Yusnaeni & AD, 2017).

## CONCLUSIONS

The conclusion drawn from the data analysis and hypothesis testing is that Moodle-assisted e-learning influenced students' concepts understanding ability and critical thinking skills. Furthermore, Moodle-assisted e-learning and Whats App-assisted e-learning influenced students concepts understanding and critical thinking skills.

The research was limited by its focus on undergraduates and the small sample size. Additionally, only the cognitive aspect was required, and the affective aspect was optional. There was no feedback in the learning activity. The cooperative reciprocity was not regulated, which may be exacerbated by other exogenous factors such as the learning environment and the student's prior knowledge. Future researchers should be paying attention to feedback in the learning activity, which might mix with other factors such as the learning environment and students' prior knowledge.

## AUTHOR CONTRIBUTIONS STATEMENT

Based on their contributions to this research, AP and YFZ prepared the overall research, developed research instruments, and wrote articles. NS, IS, and F contributed as analytical instruments and wrote down the findings during the study. S contributed as a documentary during the research as an editor of writing articles.

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