The Effect of Using E-modules in Mathematics Subjects on Increasing Concept Understanding and Critical Thinking

Haziza, Rudy Sumiharsono, Eges Triwahyuni *
Pascasarjana S2 Teknologi Pembelajaran, Universitas PGRI Argopuro Jember
eges.triwahyuni@gmail.com .

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Abstract: This study aims to determine the influence of the discovery learning model on learning activities and student learning outcomes. The problems studied in this study are: 1) Is there any effect of using E-modules on increasing conceptual understanding in students? 2) Is there any effect of using E-modules on improving Critical Thinking in students. 3) Is there any effect of using E-modules on improving conceptual understanding and critical thinking in students together? The design of this study was quantitatively causal. The data collection method uses questionnaires, tests, and documentation. Data analysis was carried out with validity and reliability tests, classical assumption tests in the form of normality tests, multicollinearity tests, autocorrelation tests, heteroscedasticity tests, and hypothesis testing with F tests. The results showed that (1) there was an influence of the use of E-modules on increasing understanding of concepts by showing a calculated t value of 1.842 greater than t table (2) the effect of using E-modules on critical thinking by showing a calculated t value of 2.275 greater than t table (3) the results of regression analysis obtained f count 4.494 greater than f table, then there was an influence of using E-modules on increasing concept understanding and critical thinking together.

Keywords: Use of e-modules, conceptual understanding, critical thinking.

Introduction

Learning Paradigm Changes in recent decades, shifting paradigms in learning from traditional teacher-centered approaches to student-centered approaches [1]. This new approach emphasizes active, collaborative, and problem-based learning, where students are actively involved in the learning process. Learning technology has great potential to support and facilitate this approach by providing various interactive tools and resources [2]. Advances in Information and Communication Technology Advances in information and communication technology (ICT) have changed many aspects of human life, including education[3]. Developing software, hardware, and internet connectivity has opened up new learning opportunities. Learning technology can

[1] Dwiwarna and Raditya Bayu Rahadian, "The Most Considered Type of Student Characteristics by Primary School Teacher," *International Journal on Integrating Technology in Education* (2018).

[2] S A Tekege, "Hubungan Perhatian Orag Tua Dengan Prestasi Belajar Siswa Kelas IV SDN Sekarpuro Kecamatan Pakis Kabupaten Malang," *Hubungan Perhatian Orag Tua Dengan Prestasi Belajar …*, 2017.

[3] Supeno et al., "Utilization of Whatsapp Application as Communication Media in Language Teaching and Learning at FBS UWKS," in *Journal of Physics: Conference Series*, vol. 1175, 2019.

include various forms such as mobile devices, computers, the internet, applications, online learning platforms, and others. This advancement allows easier and more flexible access to learning resources, collaboration between students and teachers, and innovative learning methods [4].

Mathematics learning in the independent curriculum prioritizes a deep understanding of concepts, application in real contexts, and the development of students' critical thinking skills[5]. Mathematics learning is no longer limited to imparting knowledge and using formulas, but emphasizes problem solving, creative thinking, and the development of intuitive understanding. Students are invited to dig Based on the results of document studies and interviews with mathematics teachers at Glenmore State High School, researchers found conditions where teachers still use learning media in the form of learning textbooks and learning planning indicators are still at a low stage at level 1 (C1-C2). While referring to learning outcome data, 67% of students are still complete. From this information, researchers have the initiative to use e-modules to determine the effect of increasing students' understanding of concepts and their critical thinking skills. E-modules for learning mathematics are intended to be accessible online through computers, laptops, or tablets. Thus, students can access math materials anytime and anywhere, allowing for independent learning and more flexible time options. Some e-modules include a student progress monitoring feature, allowing teachers or students to track and evaluate their learning progress. This information can help identify areas that need more attention and provide timely feedback.

Research conducted by Rizka Nurlaili[6] E-module developed using the ASIE development model can increase the effectiveness of critical thinking with an N-Gain value of 0.74 in the high category. Nur Rizkhana Hariani's results showed that the average understanding of experimental class concepts was higher than the average understanding of control class concepts. The increase in understanding of experimental class concepts is 0.50, falling into the medium category. The results of the response questionnaire analysis showed that students responded positively to the learning model applied. These results show that applying the e-module-assisted guided inquiry learning model has a positive influence, which can increase students' understanding of concepts.

Methods

This study used causal quantitative research methods. According to Sugiyono [7]the causal quantitative approach is an approach in research that looks for relationships between one variable and another variable with cause and effect. This research tests the established hypothesis and looks for the influence between the independent and dependent variables.

The place of research is an area that will be used as a place to conduct research. To determine

[4] Rumondang Florentina Turnip and Hari Karyono, "Pengembangan E-Modul Matematika Dalam Meningkatkan Keterampilan Berpikir Kritis," *Jurnal Edukasi Matematika dan Sains)* (2021).

[5] Siti Lailiyah et al., "Levels of Students' Mathematics Anxieties and the Impacts on Online Mathematics Learning," *Cakrawala Pendidikan* (2021); Tatiana S. Sheromova et al., "Learning Styles and Development of Cognitive Skills in Mathematics Learning," *Eurasia Journal of Mathematics, Science and Technology Education* (2020).

[6] Rizka Nurlaili, Siti Zubaidah, and Heru Kuswantoro, "Pengembangan E-Module Berbasis Discovery Learning Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Kelas XII Berdasarkan Penelitian Analisis Korelasi Kanonik Dari Persilangan Tanaman Kedelai," *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan* (2021).

[7] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, Dan R&D* (Bandung: CV. Alfabeta, 2017).

the research area, the researcher uses the *Purposive Sampling method*. Sugiyono [8] stated that a *Purposive Sampling Area* is a sampling technique with certain considerations. The research design in this study was causal and quantitative. Research that reveals the impact of certain variables (independent) on other variables (bound). In this study, researchers wanted to determine whether using e-modules for mathematics subjects effectively increased conceptual understanding and critical thinking in grade XI MIPA 1 students of Glenmore State High School in the even semester of the 2022/2023 academic year.

Data collection techniques are the most important step in research, because the main purpose of research is to obtain data. Without knowing data collection techniques, researchers will not get data that meets the established data standards[9]. The data collection methods used to obtain data are Observation, Interview, and Documentation. Observation Method: One technique that can be used to find out or investigate non-verbal behavior is observation techniques. According to Sugiyono [10] observation is a data collection technique that has specific characteristics when compared to other techniques.

Observation is not limited to people, but also other objects of nature. Through observation activities, researchers can learn about behavior and the meaning of that behavior. The observation in this study is made directly in the field to find out the actual condition of micro traders in Menteng District to apply to record using the Gross Profit method to make monthly financial statements. According to Moleong [11] , the key to the success of observation as a technique in data collection is very much determined by the researcher, because the researcher sees and listens to the object of research and then concludes from what is observed.

Interview Method: An interview or interview is a method of taking data by asking something to someone who is an informant or respondent. The trick is to have a face-to-face conversation.10 Interviews can be conducted using interview guidelines or by direct questioning. In the interview process using general guidelines, the interviewer lists the issues that must be covered without specifying the order of the questions. Interview guidelines are used to remind researchers (interviewers) about aspects that must be discussed and to be a checklist (checklist) of whether these relevant aspects have been discussed or asked. With such guidelines, researchers must consider how the question will be described concretely in question sentences, while adjusting the question to the actual context during the interview. Interview guidelines are used so that the interview does not deviate from the purpose of the study. Interview guidelines are prepared based on research objectives and theories related to the problem under study.

Documentation Method: The documentary method or technique is a technique of collecting data and information through the search and discovery of evidence. The collected documents will help researchers understand the phenomena that occur at the research site and help interpret data. In addition, documents and literary data can help theorize and validate data. Measurement Scale: The study uses the Likert scale for its assessment.

1. Test Assessment Instruments

[8] Prof Sugiyono, "Metode Penelitian Kombinasi (Mixed Methods)," *Bandung: Alfabeta* (2015).
[9] Lexy J. Moleong, *Metodologi Penelitian Kualitatif* (Bandung: PT. Remaja Rosdakarya, 2018).
[10] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, Dan R&D*.
[11] Moleong, *Metodologi Penelitian Kualitatif*.

a). Validity Test: The validity test is used to test whether the instrument used
valid. This means the instrument can be used to measure what is being measured. The results of the instrument are called valid if the data collected with the actual data occurs in the object under study. The questionnaire is valid if the correlation value R is calculated > the table R (Sugiyono, 2008: 248). Instrument testing uses a sample of 33 people, which is intended so that the question items in the questionnaire have a reliable level of validity because the intended value of the table is quite high.

The result r is calculated compared to r table, where to find r table is to find the degree of freedom df = n-2 with 5% significance and 98% confidence level using a one-tail test. Validity tests were carried out on each research variable. How to measure variables

$$r_{xy} = \frac{N\Sigma xy_{-(\Sigma x)}(\sum y)}{\sqrt{(N\Sigma x^2 - (\sum x)^2(N\Sigma y^2 - (\Sigma y)^2)}}$$

Information:

r : Pearson correlation coefficient of validity
x : Score respondents' responses to each question
y : Responder response score to all questions
n : the number of respondents/subjects

In the SPSS program, *Pearson product moment correlation- Bivariate is used* and compares the test results of the pearson correalation test results with the r table. Criteria for whether or not a data is valid or not accepted in the SPSS program Based on correlation values:

- If r counts > r table then the item is declared valid
- If r count < r table then the item is declared invalid

Based on significance are:

- If the signification value > α (0.05) then the item is declared invalid
- If the signification value < α (0.05) then the item is declared valid

The data analysis steps to test validity in the SPSS program are as follows:

a. Calculate the number of respondents' answer scores for each question / statement item.
b. Calculate the total score of respondents' answers
c. Perform analysis using the *analyze* command then *correlation bivariate*
d. Comparing the value of r count with r table, r count is obtained by calculating the degree of freedom df = n2
e. Sorting valid and invalid items

b). Reliability Test: Reliability tests are used to test whether the instrument is reliable. Reliable if there is a similarity of data at different times. This reliability testing technique uses analytical techniques that Alpha Cronbach has developed. In this reliability test, α is considered reliable if greater than 0.6 (Ghozali, 2005: 129). The rules for determining whether an instrument is reliable or not, are as follows:

1. If the reliability of the *Cronbach Alpha* exceeds 0.6 then the instrument is reliable, and the questionnaire is reliable and usable.
2. If the reliability score *of Cronbach Alpha* is less than 0.6, then the instrument is unreliable, the questionnaire is unreliable, and it cannot be used.

a). Normality Test: The Normality Test is used to test whether a variable has normal data or not. Normal here in the sense of having a normal distribution of data. To test normality in this study using the Kolmogoriv Smirnov test with the provision if Asymp. If sig> 0.05, then the data is normally distributed.

b). Homogeneity Test: A homogeneity test is performed to determine that two or more groups of sample data come from populations with the same variance (homogeneous). In the book written by Sudjana (2005: 250), homogeneity tests can be done with levene, fisher or bartlett tests. This test is a requirement before performing other tests, such as T Test and Anova. This test ensures that the data groups are indeed from the same sample. In this study using levene's statistical analysis, it is said to be homogeneous if the intergroup variance has a significance of more than 0.05 (Sig > 0.05), if the significance value is less than 0.05 (Sig < 0.05) then the intergroup variance is not homogeneous.

c). Autocorrelation Test: The autocorrelation test aims to test whether in linear regression there is a correlation between confounding errors (residuals) in period t with errors in period t-1 (previous). If there is a correlation, there is an autocorrelation problem (Ghozali and Ratmono, 2017: 121). The autocorrelation test is related to the influence of observers or data in one variable that is interrelated with each other (Gani and Amalia, 2015: 124). This study uses the Durbin-Watson test (DW test) to detect whether or not there is autocorrelation.

d). Uji Hypoplant

a). Test t: According to Mulyono [12] the t test is used to determine whether the independent variables have a real or no effect on the dependent variable. The degree of significance used is 0.05. If the significant value is less than the degree of confidence then we accept the alternative hypothesis, which states that an independent variable partially affects the dependent variable. This test is carried out two-way test with the hypothesis:

H : $\beta = 0$

This means that the independent variable has no influence on the dependent variable. Ha : $\beta 1 < 0$ or $\beta 1 > 0$

This means that there is an influence of the independent variable on the dependent variable

1. H0 is accepted and Ha is rejected if t is calculated < ttable, meaning that the independent variable has no significant effect on the dependent variable.
2. H0 is rejected and Ha is accepted if tcount > ttable, meaning that the independent variable significantly affects the dependent variable.

b). Test F: According to Mulyono [13] , the F test is used to determine whether the independent variables simultaneously significantly affect the dependent variable. The confidence degree used is 0.05. If the F value of the calculation result is greater than the F value according to the table, then an alternative hypothesis, which states that all independent variables simultaneously have a significant effect on the dependent variable.

Ho is accepted, if Fcalculate ≤ Ftable or sig value > 0.05

Ho is rejected, if Fcalculate > Ftable or sig value < 0.05

If there is an acceptance of H0, it can be interpreted as an insignificant multiple regression model

[12] H Mulyono and Ismail Suardi Wekke, *Strategi Pembelajaran Di Abad Digital*, Pertama. (Jogjakarta: Gawe Buku, 2018).

[13] Mulyono and Wekke, *Strategi Pembelajaran Di Abad Digital*.

obtained, resulting in an insignificant influence of independent variables together (simultaneously) on the dependent variable.

Result And Discussion

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Use of emodules	33	60	117	98,85	13,951
Concept Understanding	33	41	70	59,18	9,036
Critical thinking	33	41	65	53,64	7,084
Valid N (listwise)	33				

(Data processed 2023)

All collected questionnaires are tabulated for data analysis purposes. The data tabulated is all respondents' responses or answers to each question in the questionnaire. The questions are related to the use of emodules in Mathematics subjects to understand concepts and the ability to think critically.

Table 1.Table of Reliability Test Results of Game Based Learning Method Interview (Variable X)

Case Processing Summary

Variable reliability test X1

Reliability Statistics

Cronbach's Alpha	N of Items
,896	25

Y1 reliability test

Reliability Statistics

Cronbach's Alpha	N of Items
,868	15

Y2 reliability test

Reliability Statistics

Cronbach's Alpha	N of Items
,656	15

1. Uji Durbit Watson

Model Summaryb

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson

1	,349a	,122	,063	13,501	1,982

a. Predictors: (Constant), Critical Thinking, Conceptual Understanding

b. Dependent Variable: Use of emodul

2. Uji Regresi

Coefficient						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Say.
		B	Std. Error	Beta		
1	(Constant)	21,696	11,434		1,898	,067
	Critical thinking	,454	,225	,294	1,842	,075
	Concept Understanding	,407	,217	,364	2,275	,030
a. Dependent Variable: Use of emodul						

Table 2. Table of Homogeneity Test Results

Data Group Variants	Levene's Statistic	Say	Information	Conclusion
GameBased Learning Methods and Gross Motor Skills and Social Emotional Skills	2413	0,071	Sig>0,05	Homogeneous

Table 3. Autocorrelation Test result table Model Summary

Model Summaryb

Model	R	R Square	Adjusted Square	RStd. Error of the Estimate	Durbin-Watson
1	,349a	,122	,063	13,501	1,982

(Data processed, 2023)

The results of the autocorrelation test using the Durbin-Watson test obtained a DW value of 1, Based on the output of the Model Summary above, it is known that the value of Durbin-Watson (d) is 1.982. This value will then be compared with the value of the Dubrin-Watson table at 5% signification with the formula (k ; N). The number of independent variables is 1 or k = 1 and the number of samples or N = 33. Thus, (k ; N) = (1 ; 33). Then based on the distribution of Durbin-Watson values, the dL value (lower limit) is 1.383 and the dU value (upper limit) is 1.508.

The Durbin-Watson value (d) obtained from the above output is 2, greater than the upper bound dU (upper bound) which is 1.508 and less than (4-dU) 4-1.508 = 2.492 (The Dubrin-Watson value is between dU (upper bound) and (4-dU). Thus, as the basis for decision making in the Durbin-Watson test above, it can be concluded that there are no problems or symptoms of autocorrelation.

Table 4. Linear Regression: Effect of x (Use of emodules) on Y1 (critical thinking skills)

Coefficient						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Say.
1	(Constant)	21,696	11,434		1,898	,067
	Critical thinking	,454	,225	,294	1,842	,075
	Concept Understanding	,407	,217	,364	2,275	,030

a. Dependent Variable: Use of emodul

Based on the analysis of the data above, it can be seen that the value of the constant 21.696 can thus be included in the following equation

Y = 21.69 + 0.454 + 0.407

The equation shows how the value of β= 21.69, the value of the coefficient of 21.69 can be interpreted if applying emodules is good, then students' understanding of concepts and critical thinking will increase.

Table 5. F Test Results Table

ANOVA						
Model		Sum of Squares	Df	Mean Square	F	Say.
1	Regression	404,452	2	202,226	4,994	,013b
	Residual	1214,881	30	40,496		
	Total	1619,333	32			

(Data processed 2023)

Learning is an aid provided by education so that there can be acquisition of knowledge and knowledge, mastery of skills, and the formation of attitudes and beliefs in students[14]. The results of the first hypothesis test (H1) state that using emodules in Mathematics subjects positively affects understanding concepts. The regression results show that the use of Mathematics subject modules significantly affects understanding concepts. Based on hypothesis testing, the use of emodules in Mathematics subjects has not changed, so understanding will remain good. The value of this regression coefficient is significant at the level of 5% singnificance with a p value of 0.075. The results of this test interpret that the variable Use of emodule in Mathematics subjects has a positive and significant effect on understanding the concept at the level of significance of 5% or other words H1 is rejected.

The results of testing the second hypothesis (H2) state that using emodules in Mathematics

[14] Majid Al-Amri, "Student-Led Seminars as an Active Learning Strategy to Enhance English as a Foreign Language Procrastinating Students' Achievement," *Learning and Teaching in Higher Education: Gulf Perspectives* 15, no. 1 (2018): 2–13; citra dewi Rosalina and Risma Nugrahani, "Pengembangan Media Buku Pop-Up Untuk Pembelajaran," *jurnal Peningkatan Kapasitas Hasil Penelitian dan Pengabdian kepada Masyarakat Menuju Revolusi Industri 4.0"* (2018); Sukma Sacita Dewi, Rachmaniah Mirza Hariastuti, and Arfiati Ulfa Utami, "Analisis Tingkat Kesukaran Dan Daya Pembeda Soal Olimpiade Matematika (Omi) Tingkat Smp Tahun 2018," *Transformasi : Jurnal Pendidikan Matematika dan Matematika* 3, no. 1 (2019): 15–26.

subjects on critical thinking has a positive effect. The regression results show that the use of mathematics subject modules on critical thinking skills significantly affects students' skills. Based on hypothesis testing,. The value of this regression coefficient is significant at the level of 5% singnificance with a p value of 0.30. The results of this test interpret that the variable of using the emodule of Mathematics subjects has a positive and significant effect on student learning outcomes at the level of significance of 5% or H_2 is rejected.

The results of testing the third hypothesis (H3) state that the use of mathematics subject modules has a positive effect on understanding concepts and thinking critically together. The regression results show that the use of Mathematics subject modules on concept understanding significantly affects understanding concepts and critical thinking.

The value of this coefficient is significant at a significance level of 0.05 with a p value of 0.000. It is obtained by looking at the F table with the formula df for the numerator = k, df for the denominator = n-k-1, (in this determination df for the numerator = 2, df for the denominator = 33-2-1 = 30), so that the F of the table = 3.32. F value count 4.494 > F table 3.32. Because Ha is accepted, regression models can be used to explain the influence of the independent variable on the dependent variable. The results of this test interpret that the variable Use of emodule in Mathematics subjects has a positive and significant effect on understanding concepts and thinking critically together at a significance level of 5% or in other words H3 is rejected.

Conclusion

This study aims to determine the effect of using the emodule of Mathematics subjects on the understanding of concepts and the ability to think critically. Based on the study's results, the following conclusions can be drawn: The results of multiple linear regression show that the first hypothesis (H1) positively affects the influence of the use of mathematics subject modules on understanding the concept of rejecting the existing null hypothesis. The results of multiple linear regression show that the second hypothesis (H2) has a positive effect on the influence of the application of the use of mathematics subject modules on critical thinking skills, namely rejecting the existing null hypothesis, thus showing that there is an influence of the use of mathematics subject modules on critical thinking skills. The results of the simultaneous test showed that the second hypothesis (H3) had a positive effect between the use of mathematics subject emodules on concept understanding and critical thinking together rejecting the existing null hypothesis, thus showing that there was an influence of the use of mathematics subject emodules on concept understanding and critical thinking.

It is expected to be able to practice and develop the knowledge and insights that researchers gained during their studies at the postgraduate faculty of Education learning technology program at PGRI Argopuro University (UNIPAR) Jember, East Java., It is hoped that teachers can be used as contributions of thoughts and input to help learning more effectively.

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