Eco-Mobile Learning for Enhancing Critical Thinking Skills Among University Students

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Abstract: Microeconomics learning aims to help students understand how economic concepts and theories can be used to analyze and solve economic problems in everyday life. The study aims to develop Eco-mobile learning applications as learning media intended to improve critical thinking skills in terms of the cognitive style of economic education students. This research followed the Lee and Owen's development model with the stages of need assessment and analysis, design, development, implementation, and evaluation. The research subjects were 105 economic education students taking microeconomics courses. The results of the media expert's assessment of the Eco-mobile learning application media as a whole were 94%, material experts gave an assessment of 97.3%, and student and lecturer responses to the practicality of the Eco-mobile learning application were 86.4% and 95.2%. Meanwhile, the effectiveness of the media can be obtained from the results of the critical thinking post-test scores in the experimental and control classes. Based on the overall results, it can be concluded that the Eco-mobile learning application developed in this research is suitable for use and effective in improving critical thinking skills in terms of the cognitive style of economics education students.

Keywords: Eco-mobile learning, Critical thinking skill, Cognitive style

INTRODUCTION

The twenty-first century learning requires students to use information and communication technology, be creative, and be able to think critically in solving every problem (Suryanda et al., 2018; Sugeng & Suryani, 2024). Efforts can be made to prepare the future generation to compete in this global era, namely by improving the quality of education through learning reform. The reform in question is a shift from traditional learning (low-level skills learning) to learning that emphasizes high-level thinking. Frydenberg and Andone (2011) argued that in the twenty-first century, everyone must have critical thinking skills, knowledge, and abilities of digital literacy, information literacy, media literacy, and master information and communication technology. This remarks that in the world of education, critical thinking skills are a necessity for students, so educators must be able to enhance critical thinking skills in students.

Critical thinking is a skill that must be possessed by students and must be enhanced among students (Anugraheni, 2019; Nuryana et al., 2024). Critical thinking is a process that leads to mental activities such as problem-solving skills, learning to make decisions, analysis skills, and conducting scientific research (Khoiriyah & Husamah, 2018; Wahyudi, 2020). In addition, a prior study noted that critical thinking is the ability to understand, analyze, and evaluate information and

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make reasoned and rational decisions (Agnafia, 2019). This ability is a prominent skill for students in solving problems and making decisions in everyday life (Ulfa, 2020). In line with this, Yanwar and Fadila (2019) stated that problems encountered in everyday life can be solved with the help of critical thinking skills.

One factor that needs to be considered in developing students' critical thinking skills is cognitive style. The cognitive style will influence students in understanding problems, so that problem-solving strategies are heavily influenced by students' cognitive styles (Hardiyanti et al., 2019). According to Happy and Widjajanti (2014), the cognitive style of each student is not always the same. This indicates that each individual has a different way of thinking. In this case, individual differences in thinking can be known as cognitive styles. Some preliminary studies (e.g., Ngilawajan, 2013; Purwanti et al., 2016; Ariawan & Nufus, 2017; Nufus & Ariawan, 2018) revealed that a person's characteristics or way of receiving, analyzing, responding, and organizing their thoughts, connecting their experiences and the approach used involving cognitive, can be called cognitive style.

Cognitive styles can be divided into two: field-dependent and field-independent cognitive styles (Witkin et al., 1977). The field-independent cognitive style tends to be more independent and self-confident, while the field-dependent cognitive style tends to rely on external conditions (Son et al., 2020). In this research, both types of cognitive styles will be used. Ariawan and Zetriuslita (2021) stated that students with the field-independent cognitive style have mathematical critical thinking skills with very critical criteria, while students with the field-dependent cognitive style have mathematical critical thinking skills with moderately critical criteria. Another study by Ulya et al. (2014) showed that students with a field-independent cognitive style tend to like analysis and problem-solving. Field-independent cognitive style can understand the problem better than subjects with a field-dependent cognitive style (Ngilawajan, 2013; Son et al., 2020). In addition, Ariawan and Nufus (2017) revealed that subjects with a field-independent cognitive style have mastery of concepts and better analysis; they answer according to what they think.

The connection between critical thinking skills and economic learning is closely linked. Economics is a field of study that discusses how people make choices and manage resources to meet their needs (de Bruijn & Antonides, 2022). This means that with critical thinking skills, students can analyze information and understand how economic concepts influence decision-making and solving economic problems, as well as assist students in evaluating and questioning hypotheses and economic theories rationally based on this information. This can be realized in introductory microeconomic learning which studies consumer and company behavior as well as determining market prices.

This lesson also discusses how these various decisions and behaviors affect the supply and demand for goods and services. Individuals will combine consumption and production to achieve balance with ceteris paribus assumptions, especially in price determination material, which discusses how the mechanism for determining the output and price of an item is determined by the interaction between demand and supply in the goods market through a market mechanism. The introductory microeconomics course effectively raises students' curiosity, which can stimulate students' cognitive and critical thinking abilities (Kurniawati et al., 2022).

The results of a preliminary investigation by researchers conducted on undergraduate economic education students taking an introductory microeconomics course show that the assessment scores for critical thinking skills and cognitive style abilities are in the low category. This can be shown from the students' critical thinking skills test results of 36.24%, with the explanation that of the five aspects of critical thinking skills, the average score is still low. Likewise, students' cognitive style abilities also received an average score of 42.28%, which can be categorized as low. In accordance with the previous explanation, students' critical thinking abilities are closely related to the existence of cognitive aspects, namely how to complete a task, explain existing information in solving problems, design procedures, and be able to provide appropriate solutions in solving problems.

Based on the preliminary explanation, one solution to improve critical thinking skills through students' cognitive styles is to use appropriate learning media, namely mobile learning media. Through the development of this media, it can create a learning atmosphere that makes students more active and motivated (Kabunggul et al., 2020). Media development cannot be separated from increasingly rapid technological developments, one of which is the use of the Internet (Said et al., 2018). Almost all levels of society have used cell phones as a communication tool, including students and educators. For this reason, mobile learning media was developed, where all learning utilizes technology and electronics in all aspects of life (Samsinar, 2020). In the field of education, almost all learning activities are transferred to the use of gadgets.

Mobile learning is a learning media that utilizes technology and information to make learning easier so that learning can be done anytime and anywhere without being constrained by space and time (Wulandari et al., 2019; Irawan & Djatmika, 2018). Mobile Learning refers to handheld and mobile information and technology devices, which can be cell phones, laptops, tablets, and others (Musahrain et al., 2017). Apart from approach, media in learning also plays an important role that we should not ignore (Rahayu et al., 2021). Choosing the right media can support the success of the learning process (Musahrain et al., 2017). For this reason, researchers try to involve media that use smartphones because smartphones are no longer a rare item nowadays. Almost all students have smartphones with the Android operating system (OS); apart from being used for social media (e.g., Facebook, Twitter, WhatsApp, Line) and games, nowadays, smartphones have shifted and are used in learning (Lestari et al., 2019).

From the results of several studies (e.g., Ngurahrai et al., 2019; Rasyid et al., 2020; Uma'iyah et al., 2023), the Mobile Learning media developed is categorized as good and suitable for use to improve students' critical thinking. Some of the research results that have been explained previously, most of the research was conducted in the field of science and the development of Mobile Learning media only to find out directly about the increase in critical thinking skills, but there has been no previous research that measures the increase in critical thinking skills in terms of cognitive style through the use of Mobile Learning media. Therefore, this study aims to fill the research gap in these previous studies. For this matter, the researcher tried to develop the Eco-mobile learning application to improve critical thinking skills in terms of students' cognitive styles in learning economics.

The remainder of this paper is structured as follows. The methodological section is presented in the following section, accompanied by results and discussions. The last section presents the conclusion and implications, as well as the limitations of this present study.

METHODS

Design and Development Research Model

The development model used in developing this instructional media is the model from Lee and Owen (2004.) Lee and Owens's development model is applied with the consideration that this model is a multimedia-based instructional design development model, and its steps are arranged systematically with clear steps in developing learning media. The steps in Lee and Owen's development are shown in Figure 1.

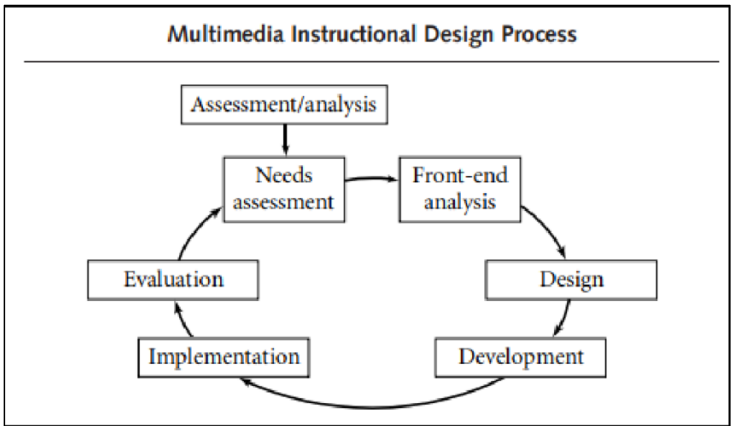

Figure 1. The development model from Lee and Owen (2004)

The Research and Development (R&D) model from Lee and Owen (2004) requires five procedural steps to produce a final product that is ready to be implemented in educational institutions. The following are the stages of the development model:

1. ***Multimedia Need Assessment and Analysis***. This analysis stage is divided into two parts. First is needs assessment analysis, which is a systematic way to determine what is needed and provide solutions according to needs. Second is front-end analysis, namely analysis from start to finish so that the analysis is comprehensive to determine the solution needed.
2. ***Multimedia Instructional Design***. At this design stage, the researcher collects information from the assessment carried out, analyzes it, and makes decisions to design multimedia mobile learning project activities. At this stage, the researcher performs scheduling, creates a work team, creates media specifications, describes the content that is prepared, organized, and operated. by the user, and finally the researcher describes the program control settings and how the media elements are well designed.

3. ***Multimedia Development and Implementation***. The development and implementation stage are developing the program in accordance with the design plans that have been created. The work team and researchers at this development stage work according to the division of tasks, until then the work results from each section are combined at this development stage.
4. ***Multimedia Evaluation***. The final stage is to perform an evaluation. The purpose of conducting an evaluation is to determine the effectiveness and efficiency of the program or product produced to provide further recommendations. Evaluation can also be aimed at knowing the response and impact resulting from the multimedia program that has been created by the researcher.

Subject, Time, and Place of Research

The subjects in this research were 105 undergraduate students of economic education at FKIP PGRI Argopuro Jember who took the Introduction to Microeconomics course. This research was carried out in January - April 2024. The experimental and control classes in this research were determined using a homogeneity test.

Research Instrument

The research instruments used include validation sheets (materials and media). Meanwhile, to test the practicality of the media, student and lecturer response sheets via questionnaire were used. The effectiveness of the media was obtained from the results of post-tests on students who were taking introductory microeconomics courses through critical thinking skills test instruments.

Data Collection Technique

Data collection techniques are the most strategic steps in this research because the main goal is to obtain data. This research uses learning media validation results sheets, which are assessed by media and material experts using the following criteria (see Table 1). Meanwhile, the criteria for the practicality of learning media can be seen in Table 2.

Table 1. Validity Interpretation Criteria

Percentage Score	Criteria
85.01 % –100.00 %	Very Valid, or usable, needs revision as suggested
70.01 % – 85.00 %	Valid, or usable but needs minor revisions
50.01 % –70.00 %	Invalid, it is recommended not to use it because it needs major revision
01.00 % – 50.00 %	Invalid, or may not be used

The questionnaires used to collect data in this research consisted of three types: questionnaires for material experts, questionnaires for media experts, and questionnaires for users. Questionnaires for material experts and media experts are used for product validation. A questionnaire for users is used to assess the practicality of the Eco-mobile learning application as a learning medium. This research also used tests to collect data, namely cognitive style tests, which were measured using the GEFT (Group Embedded Figure Test). Meanwhile, the critical thinking skills test takes the form of essay questions (Ennis, 2011).

Table 2. Practicality Interpretation Criteria

Percentage	Practically Level	Decision
85.01 – 100.00%	Very practical	Can be used without revision
71.00 – 85.00%	Practical	Usable but needs minor revision
50.01 – 70.00%	Not practical	It is recommended not to use it because it needs revision
01.00 – 50.00%	Impractical	Cannot be used

Data Analysis

Test prerequisites for analysis using normality and homogeneity tests, for hypothesis testing using descriptive and comparative analysis. In testing the hypothesis, two-way analysis of variance (ANAVA) was used to determine the differences in critical thinking skills test results between experimental class and control class students. As well as knowing the differences in critical thinking skills test results between students who have field-independent and field-dependent cognitive style abilities in the experimental class and control class.

RESULTS AND DISCUSSION

Analysis

The first stage of the Lee and Owen (2004) development model is the analysis stage. This stage is carried out to determine conditions in the field and collect information related to the learning process. The analysis stage in the model includes the need assessment stage (needs analysis) and front-end analysis (comprehensive analysis). At the need assessment stage, the techniques used are field observation, initial tests, and interviews. The results of the needs analysis show that the learning activity process has not maximized media that can measure critical thinking skills through varied cognitive styles in solving problems. During evaluation activities, students are less active in learning due to the lack of use of the latest technology. Thus, when students use smartphones online, they are only used to access reference materials, play games, social media, and communicate. This means that in the learning process, students are still not utilizing their smart devices as tools or media that can develop their potential, especially critical thinking skills, through their cognitive style abilities. Meanwhile, front-end analysis consists of user analysis, technology analysis, situation analysis, task analysis, critical-incident analysis, goal analysis, media analysis, data analysis, and cost and benefit analysis.

Design

For designing Eco-mobile learning, this study followed several matters, including schedule, project team, media specification, lesson structure, and configuration control and review cycles.

1. ***Schedule.*** The Eco-mobile learning application media development schedule starts from January to April 2024. The following is the media development implementation plan with a task schedule as in Table 3.

Table 3. Development Implementation Schedule

No	Stages	Month (Year 2024)															
		January				February				March				April			
		1	2	3	4	1	2	3		1	2	3	4	1	2	3	4
1	Analyze																
2	Design																
3	Develop																
4	Implement																
5	Evaluate																

2. ***Project Team.*** At this stage, we explain the role and structure of the personnel involved in developing the Eco-mobile learning application media, including learning media experts and material experts who are experts in the field of microeconomics or economics, media design, and coding experts, as well as stakeholders, namely lecturers who teach introductory microeconomics courses for undergraduate economic education students' class of 2023.
3. ***Media Specifications.*** Media specifications explain the details of the learning media that will be created, namely mobile learning media. The type of learning media product that will be produced is a mobile learning application developed in accordance with learning outcomes in pricing material and will be operated using an Android-based smartphone. This learning media development contains text, images, sound, and video with tools via the Kodular web app creator, which can be displayed on a smartphone. The development of learning media also includes profiles, instructions, competency maps, learning outcomes, materials, simulations, quizzes (Quizizz apk), and discussion forums via WhatsApp groups.
4. ***Lesson Structure.*** The material structure containing the material presented in making this mobile learning application media comes from the introductory microeconomics module book on the subject of price determination, which is studied by second-semester students of the Universitas PGRI Jember economics education study program.
5. ***Configuration Control and Review Cycles.*** The configuration control and review cycle describe how to control, design, and organize media elements. The learning media developed will be provided with technical instructions for using mobile learning media in the form of applications, as well as preparing everything that will be tested by experts for review, recording recommended improvements, and preparing assessments/questionnaires. The media review cycle starts from validation with media experts and material experts, then tested on students through individual trials (one-to-one trials), small group trials, and field trials. After that, the product will be improved and continued with the evaluation stage in the field to determine the practicality and effectiveness of using the Eco-mobile learning application as a learning medium to improve critical thinking skills in terms of the field-independent and field-dependent cognitive styles of economic education students.

Development

At this development stage, the plans that have been made at the design stage are implemented. All materials that will be used in media development, such as making

story boards (storyline), inputting and editing images, preparing material, inputting material and the first page of the media to be developed, as well as compiling a questionnaire which aims to determine the quality of the appropriateness of learning media and validation media experts and material experts.

Implementation

The first step is the validation stage of learning devices or media by media experts. This stage aims to assess the Eco-mobile learning application as a learning media that has been created by consulting validators. The expert assessment provided by two learning media lecturers can be seen in Table 4. Based on media expert validation, the Eco-mobile learning application as a learning medium has good quality, as seen from all aspects, namely very good. This media is also suitable for use, but there are several suggestions for improvement.

Table 4. Validation Results by Media Experts After Revision

No	Aspect	Validator 1		Validator 2	
		%	Category	%	Category
1	Display/Media Design Aspect	94.5	Very Valid	92.7	Very Valid
2	Characteristic Aspect	95.5	Very Valid	91.1	Very Valid
3	Access and Use Aspect	92.5	Very Valid	97.5	Very Valid
Average Value (%) (Each Validator)		94.2	Very Valid	93.76	Very Valid
Average Total Score (%)		94			
Total Category		Very Valid			

Next, material expert validation reviews aspects related to the delivery of pricing material. Material experts are lecturers who teach introductory microeconomics courses. This skill is relevant to the material in the Eco-mobile learning, namely demand, supply, price, and elasticity of demand and supply. The results of the material expert validation are summarized in Table 5.

Table 5. Results of Media Validation by Material Experts

No	Aspect	Validator 1		Validator 2	
		%	Category	%	Category
1	Aspects of Material Organization	95.5	Very Valid	97.8	Very Valid
2	Language Aspects	95	Very Valid	100	Very Valid
3	Aspect of Curiosity	100	Very Valid	100	Very Valid
4	Aspects of Depth of Material	94	Very Valid	96	Very Valid
Average Value (%) (Each Validator)		96.1	Very Valid	98.5	Very Valid
Average Total Score (%)		97.3			
Total Category		Very Valid			

Based on material expert validation, the Eco-mobile learning application media is of good quality, as seen from all aspects. This media is also suitable for use, but there are suggestions for improvement. The suggestions for improvement include providing examples of price problems regarding supply and demand, because they still need to be added. Overall, the Eco-mobile learning application media that has been developed by researchers can be tested. There are several suggestions given by material experts, namely, that the material contained in the

media is not too dense so that it does not take up much space on the media, because most students do not really understand how to make graphs on the elasticity of demand and supply material. Therefore, revisions are needed, and the researcher made revisions to the suggested part.

Research Instrument Validation

1. ***Cognitive Style Test Instrument.*** This test is provided theoretically and empirically. First, the theoretical validation of the questions is carried out by experts using cognitive style and statistical analysis. The theoretical validation test results of cognitive style test questions in the content, construct, and description aspects of the test are in the very good category. This can be strengthened by the results of Validator 1 and Validator 2's assessments on the cognitive style instrument validation sheet. Meanwhile, the table of statistical validation test results for the cognitive style test questions shows that the 20 cognitive style test instrument items developed have met the validity test criteria, namely that each question item has a Pearson Correlation value greater than r-table 0.396. Thus, it can be concluded that the 20 items on the cognitive style instrument can be used in this research
2. ***Validation of Critical Thinking Skills Test.*** Validation of the critical thinking skills test was carried out theoretically and empirically. First, theoretical validation of the questions is carried out by experts in critical thinking and statistical analysis. The theoretical validation test results of critical thinking skills test questions in the content and construct aspects are in the very good category. Meanwhile, the table of statistical validation test results for critical thinking skills test questions shows that the 10 critical thinking skills test instrument items developed have met the validity test criteria, namely that each question item has a Pearson Correlation value greater than r-table 0.396. Therefore, the 20 items on the critical thinking skills instrument can be declared suitable for use in this research. After the validation test has been fulfilled, it is continued with the reliability test on the research instrument.
3. ***Reliability Test.*** Based on the results of statistical tests, it can be explained that the reliability of the cognitive style instrument with 20 items has a Cronbach's Alpha value of 0.928 in the very high reliability coefficient category (excellent). Meanwhile, for the reliability of the critical thinking skills instrument, the Cronbach's Alpha value was 0.869 for the 10 items. The results of the reliability test on this instrument show that the reliability coefficient category is high (good). From the two instrument reliability results, it can be concluded that the instrument to be used already has reliable status and is suitable for use in this research.
4. ***Media Testing Phase***. After the product is declared feasible by experts, it is then tested on students. This implementation stage takes the form of user trial activities consisting of individual trials (one-to-one trials), small group trials, and field trials. In general, the results of comments from second-semester economic education students received a positive response. In summary, almost all of them said that they were very interested in the Eco-mobile learning application as a learning medium. Several students also gave suggestions for improving the ease of moving screens and video simulations in the future.

Evaluation

The evaluation process was provided to ensure that the Eco-mobile learning can be used for promoting critical thinking. The evaluation stage involved lecturers, students, users.

1. ***Lecturer.*** At this stage, the researcher acts as an observer or observer of the learning, while the lecturer who teaches the course acts as a facilitator who will carry out the learning using the media that has been prepared. In this implementation, there are two people as observers, namely one researcher himself and the second is an economic education lecturer who is also tasked with observing learning activities.
2. ***Students.*** The selection of students for the economics education study program is based on students' problems in studying microeconomics, especially regarding the analysis of students' low critical thinking skills. To support the implementation of this research, the experimental and control classes must meet the homogeneity test. The results of the homogeneity test shown in the table below explain that the sig value of the Levene test is 0.086 > 0.05, meaning that the three classes have a homogeneous distribution of critical thinking data.
3. ***Users.*** The overall student assessment results consisting of aspects of ease of media to use, ease of media to understand, attractiveness of media, as well as benefits and effectiveness of usage time in the trial class gave a score of 85.2% and implementation class of 87.2%. The overall score given by students for the practicality of the Mobile Learning application was 86.4%, meaning that it met the product practicality criteria of 85.01 - 100.00%. This means that students think that the Eco-mobile learning application is very practical to use as a learning medium. The results of the Eco-mobile learning application practicality assessment given by the lecturer show that it is very practical to use with a practicality percentage of 95.2%. This means that it can be concluded that the lecturer stated that the use of the Eco-mobile learning application compiled in this research as a whole has been very practical for use in learning activities.

The Implementation of the Eco-Mobile Learning

Hypothesis testing in this research was performed using two-way analysis of variance (ANOVA) with the help of the SPSS 25 program to determine the differences in post-test results of critical thinking skills between the experimental class and control class students as well as knowing the differences in post-test results of critical thinking skills between students who have field-independent and field-dependent cognitive style abilities in the experimental class and control class. Hypothesis testing rule: If the results show that the F-count value is greater than the F-table value and the significance value is smaller than alpha 5% (0.000 < 0.050), then the hypothesis H0 is rejected. The results of the hypothesis test on the critical thinking post-test scores for the control class and experimental class (see Table 6).

Table 6. Post-Test Scores in Experimental and Control Classes

	df	**Sum of Squares**	**Mean Square**	**F-count**	**F-table 5%**	**Sig.**
Between Groups	2	818.990	409.495	3.675	3.09	0.029
Within Groups	102	11364.343	111.415			
Total	104	12183.333				

Based on Table 6, it can be seen that in the test values for the comparison between the experimental class, positive control class, and negative control class, the F-count value and significance value were respectively 3.675 and a significance level of 0.029. These results show that the F-count value is greater than the F-table value (3.675 > 3.09), and the significance value is smaller than alpha 5% (0.029 < 0.050). Based on these results, it can be concluded that the hypothesis H0 is rejected and it can be stated that the Eco-mobile learning application as a learning media is more effective in improving students' critical thinking skills. Next, post-test scores on critical thinking skills for the experimental class and control class in groups that both have field-independent cognitive style abilities are presented in Table 7.

Table 7. Post-Test Scores in Experimental and Control Classes Who Both Have Field-Independent Cognitive Style Abilities

	df	**Sum of Squares**	**Mean Square**	**F-count**	**F-table 5%**	**Sig.**
Between Groups	2	753.569	376.784	12.225	3.18	0.000
Within Groups	48	1479.412	30.821			
Total	50	2232.980				

Based on Table 7, it can be explained that in the test values for comparison between the experimental class, positive control class and negative control, the F-count value and significance value were 12.225 and sig 0.000. These results show that the F-count value is greater than the F-table value (12.225 > 3.18), and the significance value is smaller than alpha 5% (0.000 < 0.050). The output indicates that hypothesis H0 is rejected, and it can be stated that the Eco-mobile learning application is more effective in improving critical thinking skills in groups that both have the field-independent cognitive style. Meanwhile, the results of post-test scores on critical thinking skills for the experimental class and control class in groups that both have field-dependent cognitive style abilities will be presented in Table 8.

Table 8. Hypothesis Test Results Critical Thinking Post-Test Scores in Experimental and Control Classes Who Both Have Field-Dependent Cognitive Style Abilities

	df	**Sum of Squares**	**Mean Square**	**F-count**	**F-table 5%**	**Sig.**
Between Groups	2	183.444	91.722	4.284	3.18	0.019
Within Groups	51	1092.056	21.413			
Total	53	1275.500				

As shown in Table 8, it can be seen from the test values for the comparison between the experimental class, positive control class and negative control that the F-count value and significance value were 4.284 and sig 0.019. These results show that the F-count value is greater than the F-table value (4.284 > 3.18), and the significance value is smaller than alpha 5% (0.019 < 0.050). Based on the results, hypothesis H0 is rejected, and it can be stated that the Eco-mobile learning is more effective in improving critical thinking skills in groups that both have the field-dependent cognitive style. Thus, it can be concluded that the Eco-mobile learning application is feasible and effective for use in improving the critical thinking skills of students who have both field-independent and field-dependent cognitive styles.

Discussion

Feasibility of the Eco-Mobile Learning to Improve Critical Thinking Skills

Using mobile learning applications is an efficient and effective way to convey information. In the era of globalization, the use of mobility has become a necessity to increase the efficiency and effectiveness of operations, including in learning activities to achieve a learning goal. This indicates that choosing suitable media can support the success of the learning process (Musahrain et al., 2017). Mobile learning, which is part of electronic learning, provides wider opportunities because of its mobile nature and good technological capabilities for learning. According to Clark (2000), learning is the intersection of mobile computing and e-learning: accessible resources wherever you are, robust search capabilities, rich interaction, powerful support for effective learning, and performance-based assessment.

To prove that the development of Eco-mobile learning that is suitable for use in introductory microeconomic learning with pricing material in improving students' critical thinking skills, it can be explained from the results of validation tests by media experts and material experts, media trials, and the results obtained from user responses, namely students and lecturers. The results of media expert validation show that the eco mobile learning application product developed is good in media development, especially in terms of appearance, while some errors have been corrected. There are several suggestions given by material experts, namely, that the material contained in the media is not too dense so that it does not take up much space on the media because most students do not really understand how to make graphs on the elasticity of demand and supply material, therefore revisions are needed.

A prior study by Qodriyah and Fasha (2023) stated that a learning media being developed can be said to be feasible if the data from media evaluation questionnaires by educators, media experts, and material experts obtain good or excellent eligibility qualifications. In user testing activities consisting of individual trials (one-to-one trials), small group trials, and field trials, in general, the results of comments from second-semester economic education students get a positive response. In summary, almost all of them said that they were very interested in the Eco-mobile learning application as a learning medium. The results of the assessment of user responses, namely students and lecturers, obtained very practical criteria. Referring to these results, it can be concluded that the Eco-mobile learning is suitable for use in the process of microeconomic learning activities with pricing material in improving the critical thinking skills of economic education students.

The Effectiveness of the Eco-Mobile Learning Application

Students who use the Eco-mobile learning application as a learning medium in the process of introductory microeconomics learning activities with pricing material have a relatively higher average critical thinking skills score compared to students who use Google Site and conventional media in their learning. This is based on the results of descriptive analysis of the pre-test and post-test scores for critical thinking skills that have been obtained. The results of the hypothesis test also show that the Eco-mobile learning application as a learning medium is more effective in improving students' critical thinking skills. From these results, it can be explained that there are differences in critical thinking skills between groups of students in the

experimental class of the positive control class and the negative control class. It can be stated that the critical thinking skills of students in the experimental class are better than those in the control class.

This difference can be explained when implementing the student learning process using the Eco-mobile learning application. Students are enabled to gain high learning flexibility in using this learning media. For example, students can access information and study materials anytime and anywhere. Using Eco-mobile Learning also facilitates interaction between students and course material and also the interaction between students and lecturers, and fellow students who can share information or opinions regarding various matters relating to lecture material, determining prices, or students' personal development needs. Wilson and Woodill (2011) remarked that the advantages of using mobile devices in learning are that they can make it easier for students to access data from digital sources at any time and connect anywhere quickly and flexibly. Latchem (2018) also believed that the use of mobile devices is that they can be accessed at any time, increase interaction between students and instructors, and improve student-centered learning.

This process will have an impact on the assessment activities carried out by students in solving analysis questions through their critical thinking skills, with proof that students' answers are able to analyze arguments and provide structural and rational explanations to make decisions in solving problems (Ennis, 2011). Some studies (e.g., Agnafia, 2019; Khoiriyah & Husamah, 2018; Wahyudi, 2020; Ulfa, 2020) noted that people or individuals who are able to think critically are people who are able to conclude what they know, know how to use the information to solve a problem, and are able to search for relevant sources of information to make decisions to support problem-solving. Through evaluation activities, students can maximize their analytical skills by using the Eco-mobile learning application and can be used to enhance their educational activities.

The Effectiveness of the Eco-Mobile Learning in Lens of the Field-Independent and Field-Dependent Cognitive Styles

Referring to the results of descriptive data analysis, the post-test scores for groups of students with the same field-independent and field-dependent cognitive styles between the experimental class and the positive control and negative control classes were different. The results of hypothesis testing also show that the Eco-mobile learning application is more effective in improving critical thinking skills in terms of the field-independent and field-dependent cognitive styles of economics education students. The results can be explained in the use of Eco-mobile learning, which involves students actively using their cognitive abilities to solve problems related to the subject matter. This can be understood because the advantages of using mobile learning media include increased interaction between students and instructors and improved student-centered learning (Latchem, 2018; Sarrab & Elgamel, 2013). Students also take into account their individual cognitive abilities and use what they already know and how they encode, store, and transfer information (Tan et al., 2012; Chung et al., 2019).

The effectiveness of the Eco-mobile learning application cannot be separated from the theoretical relationship between cognitive style abilities and critical thinking. As explained by Hardiyanti et al. (2019), students' critical thinking abilities

are closely related to the existence of cognitive aspects, namely how to complete a task, explain existing information in solving problems, design procedures, and be able to provide appropriate solutions in solving problems. In addition, a preliminary study Linda and Lestari (2019) also stated that critical thinking is the general term given to a variety of cognitive and intellectual skills that require effectively identifying, analyzing and evaluating, discovering and overcoming prejudices formulating and presenting convincing reasons to support conclusions and making intelligent for students and reasoned choices about what to believe and what must be performed.

In accordance with the previous explanation regarding student activities in participating in learning using the Eco-mobile learning application as a media, especially when completing assignments regarding pricing material, students are able to solve these problems critically with the characteristics of each of their cognitive style abilities, namely field dependent and field independent. This statement is reinforced by Happy and Widjajanti (2014) that the cognitive style of each student is not always the same. This means that each individual has a different way of thinking. Some prior studies (e.g., Ngilawajan, 2013; Purwanti et al., 2016; Ariawan & Nufus, 2017; Nufus & Ariawan, 2018) mentioned that a person's characteristics or way of receiving, analyzing, responding, organizing their thoughts, connecting their experiences and the approach used involving cognitive, can be called cognitive style. Even though there are personal or individual differences in cognitive style abilities, the use of Eco-mobile learning application can promote students' activities. Basically, cognitive style has a more important role than other factors for learning activities (Rifqiyana et al., 2016; Ghofur et al., 2016).

CONCLUSION

Based on the results of validation assessments from media experts and material experts, it is stated that this media is valid. The assessment results from user responses, namely students and lecturers, obtained very practical criteria, so it can be concluded that the Eco-mobile learning application as a learning medium is suitable for use in the process of economic learning activities, significantly to improve critical thinking skills in terms of students' cognitive styles. The Eco-mobile learning application is more effective than the learning media in the control class for improving critical thinking skills among university students.

This can be explained by the results of the post-test obtained by the experimental class, which were better than the positive control and negative control classes. This study drives the implications of adopting Eco-mobile learning as an effort to promote critical thinking among university students in Indonesia. It can also be used to assist the government in driving critical thinking through cognitive matters, as it is essential in the twenty-first-century education era. Like other studies, this study solely focused on the critical thinking skills for certain topics in microeconomics.

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