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DMA Application to Identify Students' Decision-Making Ability Profiles

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Abstract

This study aims to develop and validate a Decision Making Assesment (DMA) application to identify and enhance students' decision-making skills in mathematics learning, particularly among pre-service mathematics teachers at Universitas PGRI Madiun. The research employed a Research and Development (R&D) approach using the ADDIE model, comprising Analysis, Design, Development, Implementation, and Evaluation stages. The application was designed to assess higher-order thinking processes such as identifying problems, generating ideas, clarifying solutions, and evaluating their feasibility. During the development phase, the application underwent expert validation involving three experts in mathematics education, instructional media, and assessment. The average validation score was 3.57, indicating the application is valid. In the implementation phase, 94% of student respondents expressed positive perceptions, reflecting the application's high practicality. Effectiveness was confirmed by 92% of lecturers who reported that the application supported students' decision-making development. These findings highlight the application's potential to foster active, reflective, and systematic reasoning processes through mobile learning. Furthermore, it aligns with 21st-century educational demands by integrating digital technology into authentic mathematics learning contexts. The study contributes to the innovation of digital-based assessment tools that support cognitive engagement and pedagogical relevance in higher education mathematics instruction.

Keyword: Decision Making, Mobile Application, Mathematics Learning

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INTRODUCTION

The world of education is experiencing significant developments in the 21st century. This change is influenced by the rapid development of digital technology. The integration between education and technology has given rise to a new paradigm in the learning process, namely digital-based learning (Anderson, 2010)(Siemens, 2005)(Çakiroğlu, 2019). In this context, learners are required not only to access information quickly, but also to be able to process and apply it in the learning process. Therefore, higher-order thinking Skills (HOTS), including decision-making skills, become very important (Brookhart, 2010)(Sa'dijah et al., 2021)(Murtafiah et al., 2020).

Decision-making ability is a cognitive skill that plays a role in solving various complex and unexpected problems. Decision-making ability is an important cognitive skill to solve various problems that occur unexpectedly starting from the stage of generating ideas, clarifying ideas to evaluating the reasonableness of ideas (Wang & Ruhe, 2007)(Murtafiah, Lukitasari, et al., 2021b)(Murtafiah, Hacifazlioglu, et al., 2022)(Murtafiah et al., 2023). In the context of mathematics education, this ability is important because students are faced with problems that require not only numerical skills, but also deep logical and analytical thinking (Krulik & Rudnick, 1995).

Facts in the field show that mathematics learning at the higher education level, especially among prospective teacher students, is still not optimally developing decision-making skills. Learning tends to be procedural and oriented towards solving routine problems, so that students are less involved in higher-level thinking activities that require strategy selection, analysis of alternative solutions, and consideration of risks in decision making. In fact, decision-making ability is an important part of 21st century skills that are needed in future educational practices. The lack of stimulus in contextual and problem-based learning is one of the main reasons students are not trained to make logical and systematic decisions in the context of mathematics (Handayani, 2021)(Prayitno et al., 2020) On the other hand, the mathematics learning process is still carried out conventionally, with the dominance of the lecture method and the use of textbooks as the only source of learning. Students tend to be passive and less involved in exploring the material independently (Prayitno et al., 2020). The textbooks used often present material and example problems briefly and uncommunicatively, so students have difficulty in building a complete conceptual understanding (Riyadi & Fatmaryanti, 2021)

The use of technology-based media such as mobile learning applications is one of the potential solutions. Mobile learning provides flexibility for students to learn anytime and anywhere, and allows the integration of various interactive features to support material

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understanding (Crompton, 2013). In this case, Decision Making Application (DMA)-based learning model can be integrated into mobile applications as a means to develop students' decision-making skills. DMA-based applications can be an effective tool in helping students understand the structure of decision making systematically and logically. According to research by Jonassen (2011), decision-making-based learning is able to increase students' cognitive engagement and encourage them to think more reflectively. In addition, the e-IM3 (exploration, Instruction, Metacognition, and Meaningful Learning) model designed to support the development of critical and metacognitive thinking can be adapted into mobile applications to create a more effective learning experience (Rahman et al., 2022).

Some previous studies have shown the effectiveness of using learning apps in the context of developing higher order thinking skills. For example, a study by Daryanto and Daryanto & Karim (2017) showed that the use of Android-based applications in mathematics learning can significantly improve student engagement and learning outcomes. Meanwhile, a study by Retnawati et al. (2019) found that a technology-based approach that facilitates the decision-making process can assist students in developing better problem-solving strategies. Along with the increasing sophistication of technology, integrating these applications into the education system is also a challenge for educators. This requires the development of learning tools that are not only pedagogically effective, but also adaptive to the needs and characteristics of students. Research by Kurniawan & Wibowo (2023) confirms that the development of mobile learning-based applications based on the right pedagogical model can increase students' learning motivation and cognitive abilities.

Against this background, this article aims to review how Decision Making-based applications can be used to identify and develop students' decision-making profiles, and how this can be effectively applied in the context of mathematics education. This research is expected to contribute to learning innovations that are more effective and relevant to the demands of the 21st century.

METHOD

This research uses the Research and Development (R&D) approach with the ADDIE development model which consists of five main stages, namely Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was chosen because it is considered systematic and flexible in designing and developing technology-based learning products, especially in the context of decision-making ability-based assessment (Branch, 2009). The product developed in this research is a DMA-based Assessment Application, which aims to

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identify and develop the profile of decision-making ability of students majoring in Mathematics Education at PGRI Madiun University.

The following is an illustration of the development flow that follows the ADDIE model (Yahya et al., 2021) in Figure 1.



Figure 1. ADDIE Development Model Flow

At the Analysis stage, a needs analysis of students is carried out through observation of the learning process and documentation. This analysis aims to identify gaps in decision-making skills and student needs for technology-based assessment media. The Design stage includes designing the structure of the assessment application, preparing indicators for measuring decision-making skills, and designing the user interface. The Development stage focuses on the process of making applications using appropriate technological approaches, as well as content validation by experts. The Implementation stage involves a limited trial of a number of students to see the practicality of using the application in a real context. Meanwhile, the Evaluation stage is carried out through giving assignments and tests by lecturers using decision making-based assessment applications.

Data collection was conducted through two main methods, namely documentation and questionnaires. Documentation was used to record the development process, expert evaluation notes, and user responses during the pilot test. Meanwhile, the questionnaire was used to obtain student responses to the validity, practicality, and effectiveness of the assessment application. The questionnaire instrument is arranged based on a Likert scale with four answer options and refers to indicators relevant to content validity, practicality of use, and the effect of the application on improving students' decision-making skills.

Data analysis was conducted in three aspects, namely:

1. Validity, obtained through expert judgment on the content and appearance of the application. The validity formula used refers to the Likert scale assessment. The formula used is as follows (Sugiyono, 2015).

$$Average\ Validity = \frac{\sum Score\ obtained}{n}$$

Description:

n = number of items on the assessment indicator

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This learning media development research involves 3 experts as validators, namely class teachers, material experts and learning device experts. So, to find out the overall of validity, it can be found using the following formula:

$$V = \frac{V_1 + V_2 + V_3}{3}$$

Description:

V = Validity Percentage

V_1 = Number of Values of the 1st Validator

V_2 = Number of Values of the 2nd Validator

V_3 = Number of Values of the 3rd Validator

The decision making-based assessment application can be said to be valid if the combined validity results provide results more in the range of 2.50 - 3.24 with fairly valid criteria. The validity trial was carried out using a validity test sheet and analysed for validity criteria. According to Sugiyono (2018), it is shown in the Table 1.

Table 1. Criteria for Validity

Validity Criteria	Validity Level
3.25 – 4.00	Very valid
2.50 – 3.24	Valid
1.75 – 2.49	Less valid
<1.75	Not valid

2. Practicality, measured by students' responses to the ease of use of the application, interface appearance, and clarity of instructions in decision-making based assessment. The questionnaire results were analysed descriptively quantitatively to determine the percentage of positive responses from students on the indicators of practicality (Nieveen, 2007).
3. Effectiveness, analysed based on the response of lecturers who give tests through the decision-making application, as well as from student responses to the effect of the application on understanding and applying decision making in the context of mathematics learning.

RESULTS AND DISCUSSION

This research and development is carried out with various stages so as to produce a

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decision-making-based assessment application that can be used by prospective teacher students. These stages include the analysis stage, design stage, development stage, implementation stage and evaluation stage. The decision-making-based assessment application can be said to be feasible for identifying and developing decision-making ability profiles if it meets the criteria of validity, practicality and effectiveness. The discussion related to the results of research and development is as follows.

Analysis Stage

Mathematics education students at PGRI Madiun University still have difficulty in understanding mathematical concepts. Most students have not been able to demonstrate critical thinking and problem-solving skills. Thus, the ability to make decisions in solving abstract mathematical problems is also weak. This is also in line with the results of preliminary research, that students' decision-making abilities are still low (Murtafiah et al., 2021). In addition, the learning process is still carried out conventionally, such as the lecture method even though it is assisted by presentation slides and only the use of textbooks (Murtafiah, Lukitasari, et al., 2022). Students tend to be passive and less involved in exploring the material independently. On the other hand, lecturers also have not used learning media such as assessment applications to identify students' decision-making abilities.

Design Stage

After the analysis stage, the next stage is the design stage. The design stage includes the preparation of research instruments and the design of decision-making-based assessment applications. The preparation of instruments includes an instrument validation sheet consisting of 3 aspects, namely format, content and appearance as well as a response questionnaire for students (Cervantes-Barraza & Araujo, 2023). On the other hand, the design of decision-making-based assessment applications includes designing user interfaces, user experience and also tests used to determine students' decision-making abilities. This assessment application was built by software developers according to the needs of e-learning based on mobile learning (Sadik, 2014)(Wahyuni et al., 2020). The design of the decision making-based assessment application can be seen in Figure 2-9.

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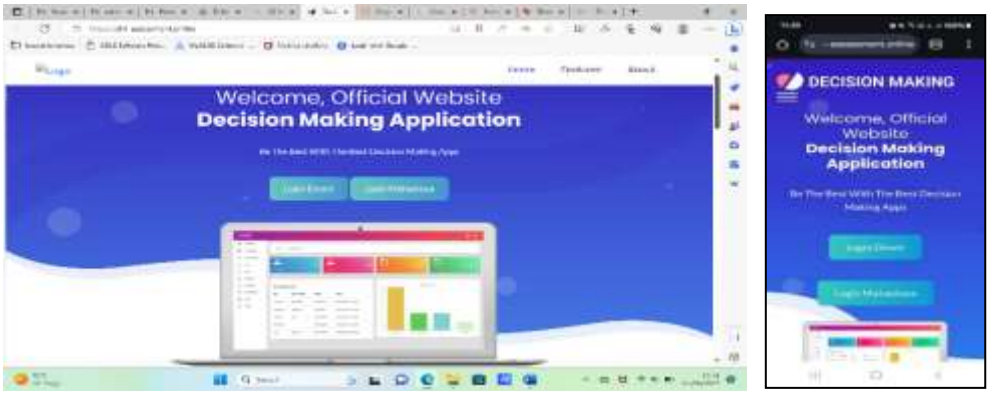


Figure 2. Decision-making assessment (DMA) application front page

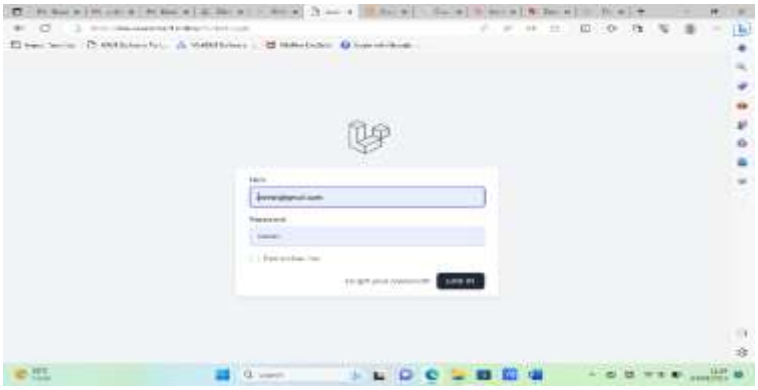


Figure 3. Decision-making assessment (DMA) application login page

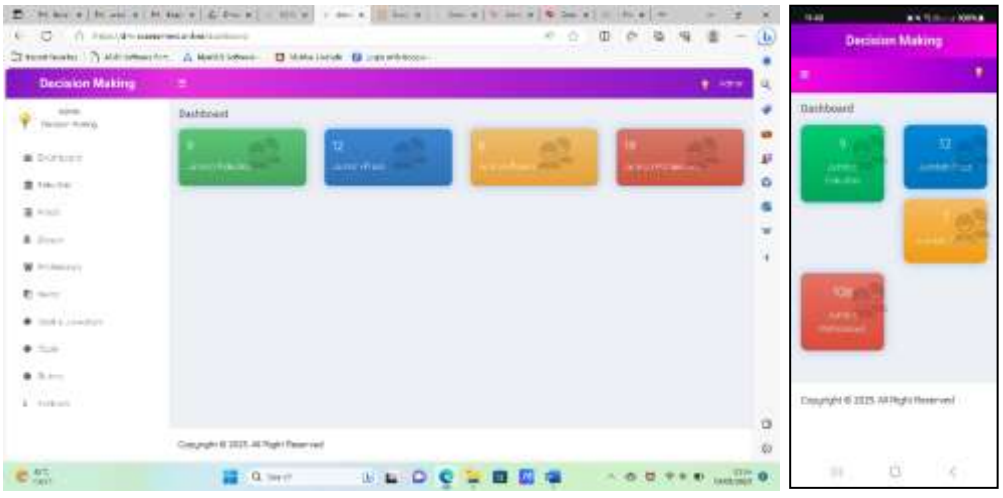


Figure 4. Decision-making assessment (DMA) application admin page

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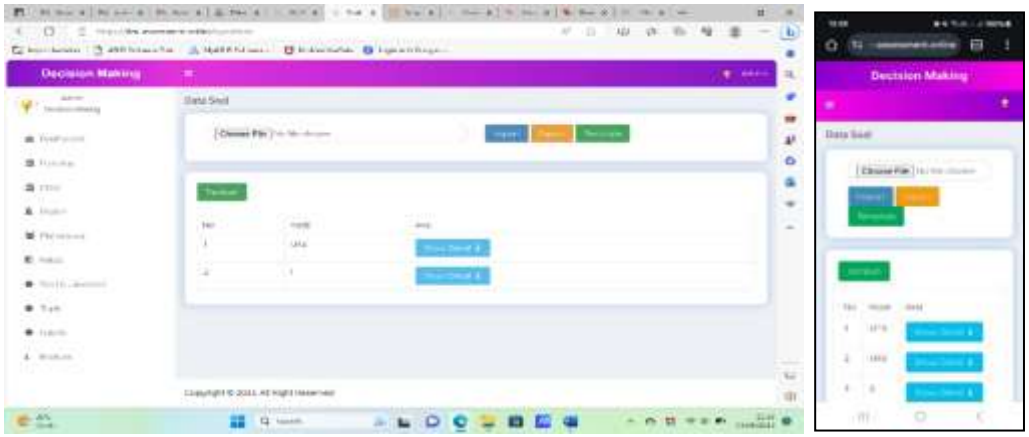


Figure 5. HOTS question list page

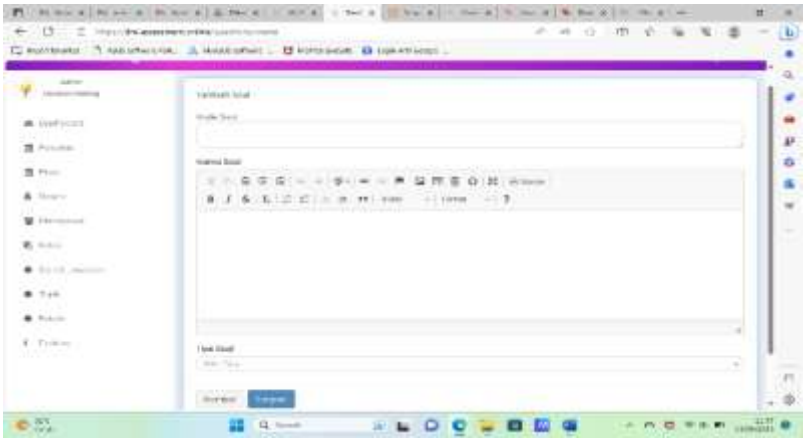


Figure 6. HOTS problem input page

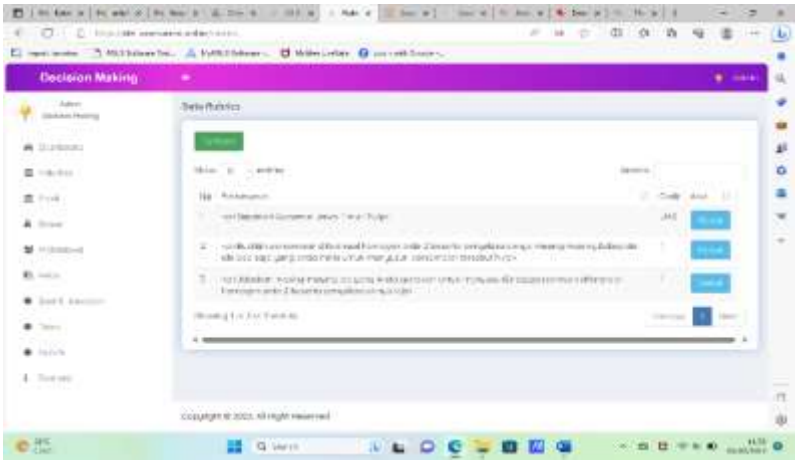


Figure 7. Rubric list page

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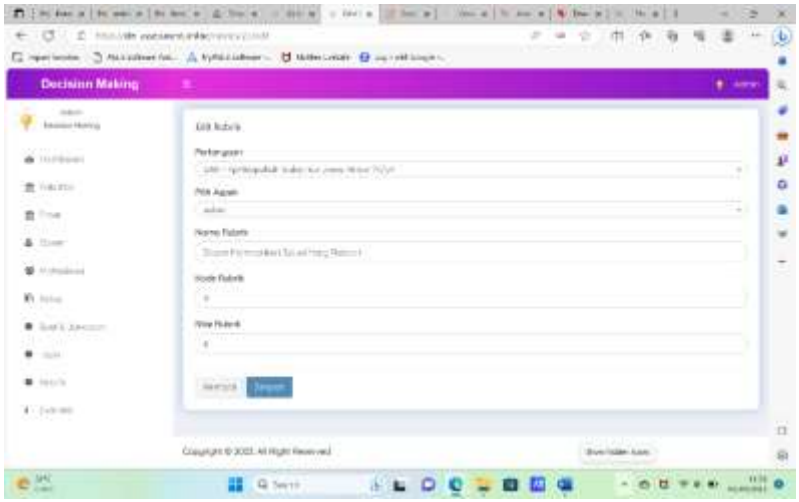


Figure 8. Rubric input page

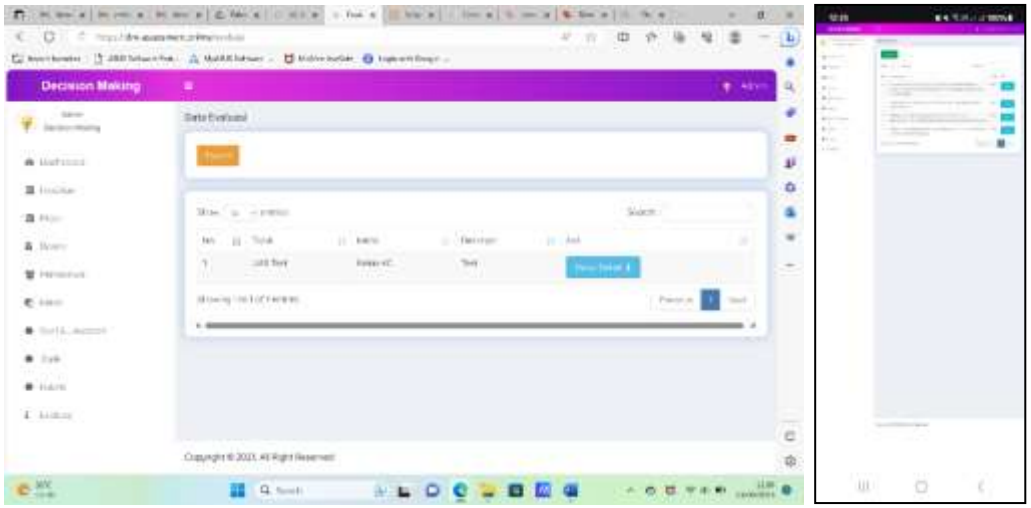


Figure 9. Evaluation result export page

Development Stage

At this stage of development, expert validation tests were carried out by 3 mathematics education experts. The first expert validation by a mathematics learning media expert, Dr. Sri Adi Widodo, M.Pd.. The second expert validation by a mathematics education expert, Dr. Muhammad Noor Kholid, M.Pd., and the third expert validation by a mathematics learning assessment expert, Dr. Hasan Basri, M.Pd. The results of the validation of the three experts are shown in Table 2 below.

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Table 2. Validation Results of Decision Making-based Assessment Application

No	Aspect	Instrument	Assessment			Average
			Validator 1	Validator 2	Validator 3	
1	Format	Completeness of menu	3	3	4	3,33
		Clear numbering system	4	4	4	4,00
		Compatibility between text and illustrations	3	4	4	3,67
		Space/layout arrangement	4	4	4	4,00
		Details of question input system	3	4	4	3,67
		Details of rubric input system	3	3	4	3,33
		Details of answer input system	3	3	4	3,33
2	Content	Grammatical correctness	3	4	3	3,33
		Suitability of content with the ability to be measured	4	3	3	3,33
		Clarity of instructions	3	4	3	3,33
		Simplicity of sentence structure	4	4	3	3,67
		Sentences do not contain double meanings	4	4	4	4,00
3	Display	Support illustrations to clarify content	3	3	4	3,33
		Provides visual stimulation	4	4	3	3,67
		Has a clear appearance	4	4	4	4,00
		Has attractiveness	4	4	3	3,67
		Type and size of letters are appropriate	3	4	4	3,67
		Easy to understand	3	3	3	3,00
Average			3,44	3,67	3,61	3,57

The results of expert validation show that the decision making assessment application developed is valid so that it can be used as an evaluation tool to measure students' decision making skills after applying the E-IM3 learning model (Restiyowati & Sanjaya, 2012)(Eskawati & Sanjaya, 2012) (Lestari & Sumarti, 2018).

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Implementation Stage

The implementation stage was carried out on students majoring in Mathematics education at PGRI Madiun University. Students responded through a questionnaire after using the decision making assessment application. The questionnaire results state that the developed application is practical to use which is indicated by the positive response of students when students work on assignments/tests using the decision making assessment application. The results of student responses to the decision making assessment application developed were 94% (> 80%) of students gave a positive response, which means that the decision making assessment application developed meets practicality (Hobri, 2010)(Kurnia & Nurhayati, 2020). This can be seen in Figures 10, 11 and 12 below.



Figure 10. Expert Testing of DMA Application



Figure 11. Trial Implementation of DMA Application for Evaluation

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Figure 12. Trial Implementation of DMA Application for Evaluation

After being tested for validity and practicality, the developed decision making assessment application also meets the effectiveness based on the responses of lecturers who give assignments/tests through the decision making assessment application. The results of the lecturer's response to the decision making assessment application developed were 92% (> 80%) of lecturers gave a positive response, which means that the decision making assessment application developed meets the effectiveness.

Evaluation Stage

At this stage, an analysis of the quality of decision making-based assessment applications is carried out which includes analyzing aspects of validity, practicality and effectiveness of decision making-based assessment applications to reveal student decision-making skills.

1. The validity of the decision making-based assessment application
   The decision making-based assessment application can be said to be valid if the validation of each validator and the combined average validation obtained meets the criteria, namely exceeding 3.00. The decision making-based assessment application obtained validity from each validator of 3.44 from the first validator Dr. Sri Adi Widodo, M.Pd, 3.67 from the second validator Dr. Muhammad Noor Kholid, M.Pd. and 3.61 from the third validator Dr. Hasan Basri, M.Pd.. Thus, the combined average of the three validators was 3.57 with a valid category to reveal students' decision making skills.
2. Practicality of decision making-based assessment application
   The decision making-based assessment application can be said to be practical if the results of the student response questionnaire are more than 80%. The decision making-based assessment application received a positive response from students of 94% with a very practical category used by students.

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3. Effectiveness of decision making-based assessment applications
   The decision making-based assessment application can be said to be effective if the results of the response of lecturers who give assignments and tests through the application. The results of the lecturer's response to the decision making-based assessment application amounted to 92% where these results have met the criteria, namely exceeding the effectiveness of 80% (Murtafiah, Krisdiana, et al., 2021).

From these results, it can be stated that the decision making application developed is feasible to be used to measure students' decision making abilities further because it meets the criteria for validity, practicality and effectiveness (Gallardo-Echenique et al., 2015)(Restiyowati & Sanjaya, 2012)(Batoon et al., 2018)(Wangid et al., 2021).

CONCLUSION

Based on the results of the research, the Decision Making-based assessment application is proven to be used to measure and reveal students' decision-making skills in learning mathematics. This is proven through three main aspects, namely validity, practicality, and effectiveness. In terms of validity, this application obtained an average validation score of 3.57 from three validators, so it is included in the valid category. In terms of practicality, the application obtained a positive response from students of 94%, which indicates that this application is very practical to use in the learning process. Meanwhile, in terms of effectiveness, the app received a positive response from lecturers of 92% when giving assignments/tests to students. Thus, the three indicators show that the Decision Making-based assessment application is feasible to use as a measuring tool to identify and develop students' decision-making skills in the context of mathematics learning.

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