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DISTANCE LEARNING STRATEGY MODEL BASED ON INTERACTIVE ONLINE TEST GAME TO IMPROVE STUDENT LEARNING OUTCOMES

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ABSTRACT
This study aimed to design a distance learning strategy based on interactive online test media on discrete mathematics material to improve student motivation and learning outcomes. The low motivation of students to learn mathematics is caused by the paradigm of mathematics, which is not a core subject in the informatics department and requires mathematics teaching staff to use new strategies and media to increase student learning motivation. The research method is mixed with developing a distance learning strategy and then ends with a test of effectiveness with the experimental process. The results of strategy development include methods, media, and time management. The resulting way is Synchronous in the form of face-to-face virtual discussions and Asynchronous in the form of material arranged in a Learning Management System (LMS), while the media developed is LMS. The experimental results found that the significant value of paired samples test was 0.00 <0.05, which means that there were differences in student learning outcomes in the experiment and control classes. The average value of the experiment class is 84.04, and the control class is 66.35, which means that the learning outcomes of students who use distance learning based on interactive online test media of discrete mathematics are better than conventional methods. Then the results of observations and student responses to distance learning strategies based on interactive online test media were declared valid and effective.

Keywords:
Development, strategy, test, game.

INTRODUCTION

Mathematics is a basic science every individual must possess to facilitate interaction and communication. For this reason, it is studied from an early age to higher education (Anderha & Maskar, 2021, p. 2). In addition, mathematics from school years based on the 2004 mathematics curriculum is expected to be able to: (1) train thinking and reasoning in conclusion, (2) develop creative activities involving imagination, intuition, and discovery by developing divergent, original thinking, curiosity, making predictions and guesses, and trying to try, (3) develop problem-solving skills, and (4) Develop the ability to convey information and ideas.

Thus, mathematics as part of the primary education curriculum plays a strategic role in improving the quality of Indonesian human resources (Depdiknas, 2013, p. 6). Based on the above, it can be said that learning mathematics is essential because it trains the ability to think critically, logistically, analytically, and systematically.

Mathematics is the scientific basis for information technology, namely computer science(Wahyuningrum & Usada, 2019, p. 3). The world is currently in the era of technology, and technological developments have changed the order of life and

human civilization, including education. Teaching and learning are different and must follow existing developments(Rumahorbo, 2021, p. 51). The development of the field of technology will not be realized without mathematical concepts as the basis of computer technology. Thus mathematics has become a fundamental science in information technology.

Mathematics in the development of information technology provides its contribution. Various computer applications and programs cannot be separated from the application of mathematical applications, including Boolean Algebra operations, graph theory, discrete mathematics, symbolic logic, probability, and statistics. This growing technology shows human development in applying mathematical applications in developing other fields. One example is the application of discrete mathematics in the development of computer technology. Important areas of applied mathematics include linear programming, coding theory, and computer theory(Farah Dzil Barr, 2020, p.13).

Information technology and mathematics are closely related. The basis of informatics engineering is to make a program with a computer language following the programming logic and the Program's purpose, which is then called software. Making software requires mathematical concepts, which include a). mathematical logic, b). set theory, c). Mathematical induction, d). Number system, e). Matrix, f). Relations and functions, g). Sequences and series, h). Boolean Algebra, i). Combinatorial, j). Discrete Mathematical Probability Theory, and k). graph theory(Syaifudin et al., 2018, p. 4). Each concept is implemented to develop software that can meet needs or solve existing problems. Based on this, every individual who wants to become a programmer or software maker should learn every mathematical concept described above. This means that the ability in the field of information technology can not be separated from the ability of mathematics.

Seeing the importance of mathematics in informatics engineering, mathematics learning in the informatics engineering education environment should receive more attention. This means that the paradigm of students who are still the majority do not like mathematics must be reduced. The concept of learning mathematics in the classroom should be improved, and even the techniques used in learning mathematics in the informatics class are constantly updated following the increase in the abilities and competencies of students every year. In fact, from the results of Wahyuni's research, it was revealed that the achievement of each indicator of mathematical understanding and reasoning abilities reached an average of 40%. The average student error is caused by not being thorough, not understanding the concept, and forgetting or having a wrong concept(Wahyuni & Kharimah, 2017, p. 228).

In addition, mathematics courses are still problematic, and students still have difficulties(Kusumaningrum & Lestari, 2019, p. 96). It is often found that some students have a negative view of mathematics subject matter, even assuming that mathematics in the information technology department is not too mandatory to be pursued because it is not a major that is taken, but mathematics is seen as a complementary or supporting course. The result of negative responses and lack of understanding of the importance of mathematics in the department of information technology is the lack of interest and attention students give to mathematics courses in the department.

The above conditions were strengthened through the distribution of questionnaires on the responses of informatics engineering students to mathematics courses distributed to students majoring in informatics engineering at several campuses, namely STMIK Mataram, Pancasila University, National University, Perbanas

University, STMIK Banjarbaru, Nusa Mandiri University, and several other campuses. Accessible to researchers. From student responses, 43.5% of the 496 students responded that mathematics courses were not interesting for students. Even if given a question about mathematics courses that do not need to be held in the informatics engineering department, the questionnaire from 493 respondents received data that 46.2% agreed to be abolished, as shown in Figure 1. This condition impacts students' mathematical abilities, which are still relatively low. It affects students' abilities in mathematics informatics courses, such as programming courses, data structures, etc. This condition should concern lecturers and campus officials regarding the quality of graduates to be issued. In other words, if the quality of information technology students wants to be improved, then improving the paradigm and learning techniques in the informatics department is essential to pay attention to and improve at any time. Data structures, and so on. This condition should concern lecturers and campus officials regarding the quality of graduates to be issued. In other words, if the quality of information technology students wants to be improved, then improving the paradigm and learning techniques in the informatics department is essential to pay attention to and improve at any time. Data structures, and so on. This condition should concern lecturers and campus officials regarding the quality of graduates to be issued. In other words, if the quality of information technology students wants to be improved, then improving the paradigm and learning techniques in the informatics department is essential to pay attention to and improve at any time.

The ability of educators to prepare and carry out the teaching and learning process is one of the critical factors in fostering student interest in learning. Many studies have proven that using different methods produces different student responses. In the response of students to learning mathematics in the department of informatics engineering from 495 respondents, 41.6% stated that they were not happy to study mathematics courses in the department of informatics engineering.

Of course, the above conditions are the responsibility of the teaching staff to create more exciting teaching techniques and methods than usual. Because it is the responsibility of the teacher to foster interest and enthusiasm for learning in students in the learning process, this is in line with the expressionSulfemithat to improve the mathematics learning process. Educators need to use a fun learning strategy so that students feel interested in participating in the mathematics learning process(Sulfemi, 2019, p. 233).

Preparing scenarios for teaching and learning activities, determining learning objectives, and preparing relevant teaching materials are part of the preparation process that educators must carry out before carrying out classroom learning, as has been described in the law regarding the duties of an educator in higher education, namely transforming knowledge. Moreover, the technology they master students by creating a learning and learning atmosphere so that students actively develop their potential. Furthermore, an educator at a higher education institution, individually or in groups, must write a textbook (LAW OF THE REPUBLIC OF INDONESIA, 2012). Then the suitability of the mathematics curriculum with the needs in information technology, fun teaching techniques, a comfortable learning atmosphere, and so on can be utilized by academic staff to change the views of information technology students towards learning mathematics. Furthermore, in the end, the ability of an educator to formulate strategies and prepare learning materials is the primary key and the first in the learning process.

The ability of each educator to carry out their duties as learning designers will undoubtedly be very diverse. Each educator has their way and technique in determining the sequence of steps of learning to be carried out. The ability of an educator to start, present, and close classes is the principal capital to planning learning activities systematically(M. Atwi Suparman, 2014, pp. 260–261). This will be significantly influenced by the level of education, experience, and habits in carrying out learning process activities. Each educator has different goals and results in different approaches and teaching techniques; thus, the learning process will significantly depend on the ability of an educator to develop methods, strategies, and teaching materials. (Sutikno, 2021, p. 103). These conditions can be evaluated through the development of teaching materials used by education in each teaching period. Changes in teaching methods and strategies in the learning process are carried out in the learning process. This is because significant changes occur in students, and the material in the field of technology is changing more and more all the time. Teaching methods and strategies for one group of students may not be suitable for another group.

One of the abilities that educators must have is choosing the right strategies and approaches to convey learning messages. Specific strategies or approaches, of course, cannot be used in every different condition, meaning that a good strategy or approach is chosen based on consideration and relevance of the strategy to the characteristics, participants, materials, and learning environment that will be faced. Thus, every educator must have the ability to develop specific methods for teaching after analyzing learning needs and or being able to choose existing models or methods with notes according to the learning needs to be carried out. Faithful efforts made by educators in carrying out their duties are an overall effort to influence students from the physical and physical side, which in the field of education is called learning. Learning is a series of events that affect students so that it can facilitate changes in a behavior called learning outcomes(M. Atwi Suparman, 2014, p. 9). Thus any problems that arise in the learning process can be simulated and overcome with a good design process by educators.

As has been explained, each educator has their style and way of conveying learning messages. The preparation or activities to design learning programs is undoubtedly influenced by various factors from within and outside the educator. Factors in educators are related to their abilities, experience, mindset, and so on. In contrast, external factors such as characteristics of participants, materials, and the classroom environment's atmosphere can affect the learning design. In this study, researchers want to solve math learning problems that arise in the department of informatics engineering,

Furthermore, the development, design, and preparation of the learning process are in the realm of educational technology on the subject of instructional design or instructional design. Learning design involves developing learning objectives, content, processes, and evaluation. Researchers have studied the material for two semesters which will then be used as material to carry out development in science(Aerospace, 2021, p. 80)this research. In developing learning models, of course, development models relevant to the needs and learning environment are to be developed because each model has its advantages and disadvantages according to the goals of the originators of the model itself. Each development model aims to create facilities and a

comfortable learning atmosphere for students to maximize their learning potential and absorb information that educators convey in the learning process.

Based on some of the explanations above, it can be stated that developing a reasonable and appropriate learning model is one of the efforts that can be made to overcome various conditions of learning mathematics in information technology. With interesting approaches and learning strategies, it is hoped that informatics students' paradigms and interest in learning mathematics can change and improve. The model development offered as a solution to the problems in this study, of course, must have specific characteristics and advantages compared to other learning models. This research will develop a learning model with the concept of adult learning by utilizing interactive multimedia. The purpose of using interactive multimedia in the design of this model is to direct students to be more active and creative in solving the problems presented. This is in line with the results of research conducted by Shamsudin; namely, using interactive multimedia in the learning process can improve students' abilities and creativity and create a fun learning environment. (Elyas, 2018, p. 2).

In addition, using interactive multimedia can also help students be more interactive in the learning process. In a more innovative and interactive learning system, teachers will always be required to be creative and innovative in finding breakthroughs in learning. An educator must be able to combine text, images, audio, music, animated images, or videos in a single unit that supports each other to achieve learning goals. This is expected to increase students' motivation during the teaching and learning process so that learning objectives can be achieved(Heo & Toomey, 2020, p. 11).

The mathematics learning model in the informatics engineering department will undoubtedly differ from the mathematics learning model in the mathematics department. This is caused by the initial view of different mathematical materials, the learning objectives are different, and the built learning atmosphere will not be the same. Based on this, a unique model is needed, which should be specifically designed for learning mathematics in the information technology department. Thus, in this study, researchers are interested in developing a mathematical learning model to improve the competence and interest in learning informatics engineering students.

Based on the background of the problem described, this research focuses on developing an interactive multimedia-based mathematics learning model for informatics engineering students. Based on the focus of the problem in this study, the researchers tried to solve learning problems related to the competence and interest in learning mathematics of Informatics Engineering students, namely.

1. How is the design of the mathematics learning model in informatics engineering at Pradita University?
2. How to design an interactive multimedia-based mathematics learning model for informatics engineering students at Pradita University?
3. What are the interactive multimedia-based mathematics learning model design results for informatics engineering students at Pradita University?
4. How effective is the interactive multimedia-based mathematics learning model for Informatics Engineering students at Pradita University?

RESEARCH METHODS

The research method used is mixed, namely Research and Development (R & D) with quantitative experiments. This study uses the Research and Development (R &

D) method to design a distance learning strategy based on interactive online test media on discrete mathematics material to increase student motivation and learning outcomes, and then Quantitative methods are used to test the effectiveness of the learning model has been developed. The development method used is the steps of the system approach model of education research developed by Dick and Carey, which includes the steps (1) Identifying goals, (2) Conducting instructional analysis, (3) Identifying entry behaviors and learner characteristics, (4) Writing performance objectives, (5) Developing criterion-referenced test items, (6) Developing instructional strategy, (7) Developing and selecting instructional materials, (8) Designing and conducting the formative evaluation of instruction, (9) Revising instruction (10) Conducting summative evaluation (Gall at al., 2007)

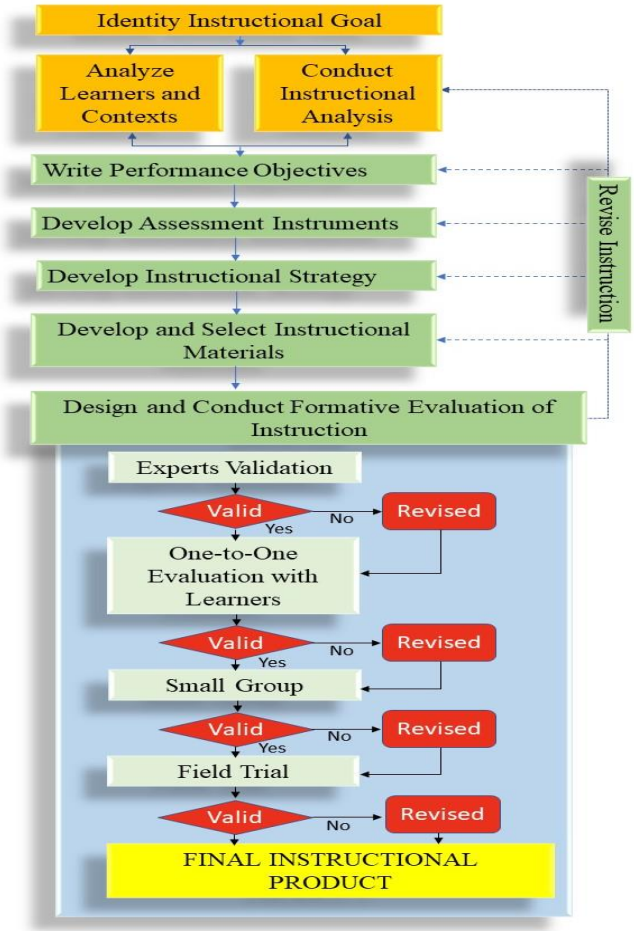

FIGURE 1. Steps Of System Approach Model Of Education Research

In general, the step of the system approach model of education research is an approach to develop a learning model as a whole in one lesson. However, in this study, the focus will be used on developing interactive online test-based learning strategies. Thus, not all steps of the system approach model of education research are implemented.

After the appropriate strategy in the research case is defined and designed, trials are carried out in the experimental class to determine the level of student response to the strategies developed. Then the experimental method is used to determine the effect of the use of the developed model on the learning process. The experiment used

was a quasi-experiment using the Paired t-test statistic, namely testing the conditions before and after treatment using pretest and posttest data.

Product Quality Measurement Technique

The product quality measurement technique is used to determine the product quality of the computer-assisted instruction-based database system learning device with a combination of the Tutorial model and the Drill and Practice model based on the aspects of validity, practicality, and effectiveness in the research as follows:

1) Aspects of Validity Measurement Techniques: The validity of this product is measured based on the visual aspect of the media, the learning aspect, the grammatical use aspect, and the material use aspect. Data analysis is done by determining the average score of the data by filling out the questionnaire. Then convert the scores that have been obtained into qualitative values on a five-scale Widoyoko (2019, p.238) as shown in the following table:

TABLE 1. Quantitative to Qualitative data conversion

interval	Criteria
X > Xi + 1.8 Si	Very Valid
Xi + 0.6 Si < X Xi + 1.8 Si	Valid
Xi - 0.6 Si < X Xi + 0.6 Si	Quite Valid
Xi - 1.8 Si < X Xi - 0.6 Si	Less Valid
X Xi - 1.8 Si	Very Invalid

Information:
X ideal: empirical score
Xi : average ideal score = 1/2 (ideal maximum score + ideal minimum score)
Si : standard deviation of ideal score = 1/6 (ideal maximum score - ideal minimum score)
Ideal maximum score = 5
Ideal minimum score = 1

Based on the conversion table of quantitative data to qualitative data, the researcher determined that for validity data, only two classifications were needed, namely valid and invalid, as shown in the following table:

TABLE 2. Product Validity Classification

Total Score Rating	Value Classification
X > Xi + 0.6 Si	Valid
X Xi + 0.6 Si	Invalid

2) Practical Aspect Measurement Techniques: The instrument used is a student response questionnaire (one-to-one evaluations and small group evaluations) with assessment criteria with scoring as shown in the table below:

TABLE 3. Product Practicality Classification

Total Score Rating	Value Classification
X > Xi + 0.6 Si	Practical
X Xi + 0.6 Si	Not Practical

3) Effectiveness Aspect Measurement Techniques: The instrument used to analyze the effectiveness of using computer-assisted instruction-based learning device products combines the Tutorial model and Drill and Practice model, comparing the pretest and posttest. Effectiveness analysis is done by calculating the percentage of student learning completeness.

Percentage of completeness (X) = (Number of students who completed/Number of students) x100%

Then the results of the percentage of students' completeness are categorized based on the criteria for assessing academic skills (Widoyoko, 2019, p.242)

TABLE 4. Product Effectiveness Classification

Total Score Rating	Value Classification
X > Xi + 0.6 Si	Effective
X Xi + 0.6 Si	Ineffective

RESULTS AND DISCUSSION

In the strategy development process, several facts related to basic needs and problems faced in the distance learning process were obtained from the analysis of the learning process needs including:

a) Learning objectives must be adjusted to a realistic level of achievement
b) The learning process tends to be boring if you only see the teacher explaining the theory on the computer layer (video conference)
c) Conference activities are considered too long if they follow the lessons usually used in offline learning.
d) Excessive assignments make students not enthusiastic about understanding the material but tend to exchange answers.
e) The absence of active control in the learning process using video conferencing results in students not seriously participating in learning activities.
f) Learning materials that are conceptual and in-depth cannot be presented only in the form of reading material.

The learning strategy that is developed is then formulated and compiled to be able to solve some of these problems. The phenomenon described will undoubtedly be resolved by designing a unique strategy to deliver the material.

1. Identifying goals. Learning objectives are formulated to be more straightforward in conceptual understanding. Mathematics in the field of informatics engineering is a Required subject and is the basis of science that can support students in learning fundamental concepts in computer science. Thus the learning objectives are directed to focus more on understanding the concept of the material provided.
2. Conducting instructional analysis.
   To achieve the goal of conceptual understanding, some specific objectives are formulated, which can then be implemented in the learning process to achieve the general learning objectives that have been set. The learning arrangement strategy is carried out by looking at the supporting objectives for the material taught. Mathematics is learning with content characteristics that are interrelated with one another. The search for content related to material that can achieve the general goal of learning worried out by reviewing and analysing content with experts.
3. Identifying entry behaviours and learner characteristics. In the distance learning process, of course, there are different student specifications from ordinary learning in the classroom. The obstacles that will be faced, and the students'

character, certainly need to be analysed to determine a good strategy. General constraints for educators who use the concept of distance learning are related to control of learning both from class control, student learning, control evaluation of learning outcomes and control of the learning process through virtual face-to-face. The strategy that is developed should be able to help the teaching staff to control each learning process that is carried out. Some basic skills required for the continuity of distance learning are generally identified, namely computer literacy and essential math skills. The characteristics of the participants based on the conditions required are as follows:

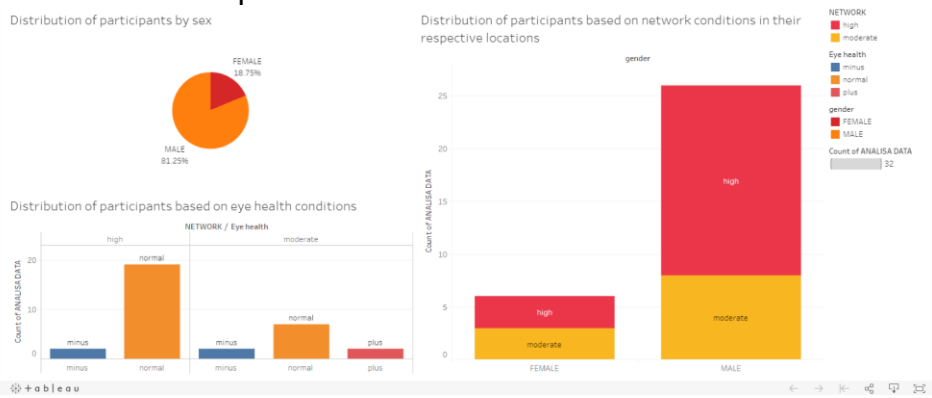

FIGURE 2. Learner Characteristics

Some of the obstacles obtained from this analysis are the lack of motivation to learn, learning that does not meet face to face is not taken seriously, neglect of online assignments and materials provided, students are not serious about taking video conferences, reasons for data packages are frequent reasons for not being able to participate learning activities directly in a virtual network.

4. Writing performance objective. To ensure that the general objectives can be achieved, specific learning objectives are prepared, which are derived from general learning objectives. The preparation strategy is carried out by formulating learning objectives using the ABCD concept. Audience (A) is a participant who will learn, Behavior (B) competencies that will be given to each formulated goal, Condition (C) as an atmosphere that will be displayed to be able to achieve the expected competence, Degree (D) Limit or level of achievement to be achieved.
5. Developing criterion-referenced test items. The test preparation is undoubtedly based on the objectives to be achieved and has been formulated in the previous step. Thus, the focus of this step is the form of questions that can be made into flexible test items for use on various digital platforms. In this case, the exam questions are made in html format and txt format that existing programs in the online system can read.
6. Developing instructional strategy. The distance learning strategy that is formulated will follow the form of a document that has been compiled. At this stage, a learning strategy is described based on the initial conditions of students and distance learning needs as follows:

source	material form	METHOD OF ACCESS			
		access	learn	identification	
Learning Materials	PowrPoin	open	answer questions on several slides	finish to the end of the slide	Asynchronous
	PDF	open	rad	make a conclusion	
	VIDEO	open	watch	make a conclusion	
	VIDEO COMPREN	open	discussion	game based exam	Synchronous
Teacers					
		Student			

FIGURE 3. Instructional Strategy

Some of the strategies shown in the table above are to avoid several things related to the obstacles to distance learning that have been described previously, namely related to the seriousness of students in learning the material, identifying participants who follow each instruction well, controlling participants in accessing the material, ensuring that participants understand the concept of the material which is studied and evaluates each virtual activity wholly and automatically identified.

7. Developing and selecting instructional materials. The selection of materials and learning tools, in this case, is based on the characteristics of students and the material to be presented. Students, in general, are still not used to learning online concepts, but they are already accustomed to using technology in their daily lives. Technology as a means of communication and social nature for students in this era, even digital world activities are more than actual activities. Thus, using a designed and designed platform to follow their digital lifestyle will be a beneficial strategy. Some of the media used to deliver material to students include
8. Learning resources. Ispring, articulate storyline: as a medium for developing learning resources that are interactive, controlled, and measurable. Camtasia, Filmora: as a medium used to develop interactive videos and animations that can put students' conceptual understanding of the expected material concepts. Quizizz, Kahoot, and ProProfs: used as an online game-based test media used in the ongoing learning process and as a cognitive evaluation tool at the end of learning. LMS: used as a distance learning system that can be accessed by

FIGURE 4. Resources and digital platform

9. Hasil uji implementasi. After the development process is carried out, the actual classroom strategy is tested.

Product Quality

1) Aspects of Validity Measurement

TABLE 5. Device validity test results

Aspect	Average Results	Criteria	Value Classification
Material or Content	5	very good	Valid
Instructional Design	5	very good	Valid
Learning Media	5	very good	Valid
Language	5	very good	Valid

Based on the results of the assessment in the table, it is concluded that Distance Learning Strategy Based On Interactive Online Test Game To Improve Student Learning Outcomes has valid criteria.

2) Practical Aspect Measurement **TABLE 3.** Product Practicality Classification

NO	RESPONDENT	AVERAGE SCORE	CRITERIA	CLASSIFICATION
1	M1	5	Strongly agree	Practical
2	M2	5	Strongly agree	Practical
3	M3	4,52	agree	Practical
4	D1	4,33	agree	Practical
5	D2	5	Strongly agree	Practical
6	D3	5	Strongly agree	Practical
7	MSG1	5	Strongly agree	Practical
8	MSG2	5	Strongly agree	Practical
9	MSG3	5	Strongly agree	Practical
10	MSG4	4,35	agree	Practical
11	MSG5	4,23	agree	Practical
12	MSG6	4,61	agree	Practical
13	MSG7	4,03	agree	Practical
14	MSG8	4,06	agree	Practical
15	MSG9	4,16	agree	Practical

Development of Interactive multimedia-based Discrete Mathematics Learning Devices based on all respondents assessing with the criteria of strongly agreeing 40% and agreeing 60% with Practical classification

3) Effectiveness Aspect Measurement

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PoEx	84.0385	26	6.93098	1.35928
	PoKo	66.3462	26	11.09574	2.17605
Pair 2	PrEx	55.9615	26	6.93098	1.35928
	PrKo	44.0385	26	7.61830	1.49407

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PoEx - PoKo	17.69231	12.82426	2.51504	12.51248	22.87214	7.035	25	.000
Pair 2	PrEx - PrKo	11.92308	12.33507	2.41911	6.94084	16.90532	4.929	25	.000

FIGURE 5. result of statistical analysis t (paired samples statistics)

The experimental results found that the significant value of the paired samples test was 0.00 <0.05, which means that there is a significant increase in student learning outcomes from before to after getting treatment. The average value of the experimental class is 84.04, and the control class is 66.35, which means that the learning outcomes of students who use distance learning based on interactive online test media of discrete mathematics are better than conventional methods. Then the results of observations and student responses to distance learning strategies based on interactive online test media were declared valid and effective.

CONCLUSION

Effective learning strategies to support distance learning must be embedded in each module content or learning processes, such as material access strategies, evaluation and participant control. Embedding activities in each material to control students can ensure that all material is read and learned by students. A technology-based distance learning strategy must adequately control the material and participants. Online media tests can be used to ensure students pass every learning process. The results of testing online test-based learning strategies can improve student learning outcomes.

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