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Development Of Discovery Learning Model-Based Learning Media To Improve Student Mathematical Reasoning

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Abstract This study aims to: 1) develop learning media based on discovery learning models that are valid, practical, and effective; 2) Analyzing learning media that can improve students' mathematical reasoning so that students easily understand it in the learning process. This research includes development research, using a 4-D centered development model to develop mathematical learning media on row and series material. Based on the results of the validity of instructional media according to the experts fulfilled the valid criteria of all indicators 0.81, the results of the first try out of practicality by the experts met the criteria of quite practical 79.7% and the results of the second trial had met the practical criteria of 85.2%, the results the first phase of effectiveness tested in the X-MM class of Istiqlal Deli Tua Vocational School did not meet the completeness criteria while the second trial met the completeness criteria. The results of the analysis of the data obtained show that discovery learning-based learning media meet valid criteria, test the feasibility of the application of practical and effective learning media and can improve students' mathematical reasoning abilities. The results of the study are recommended that practical and effective trials on learning media developed to be better carried out on different samples and used for all students at the same level.

Keywords: *ability learning media development, 4-d model, discovery learning model, students' mathematical reasoning*

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1. Introduction

The role of education through the role of science and technology in the era of the industrial revolution 4.0 in order to advance a nation and state, it requires human resources capable of implementing and mastering it, so that the achievement of the objectives of learning can adjust to the times [1]. Teachers as professional educators are human resources who are able to apply the role of science and technology in the era of the industrial revolution 4.0 in education which is required to master competencies as learning agents and students/students are the targets of achieving educational goals [2]. The role of science and technology is able to realize the goals of an educational process through multimedia if the application of the right media students as targets are able to master the sub-competencies that have been set.

Mathematical learning technology through computer devices, namely the use of multimedia is an important role able to improve the routine of the world of education which is used as a learning medium [3].

Technological developments have created breakthroughs in the learning process, students are often connected with cellular communication devices that create new trends for the learning process [4]. Learning in the current era students can access learning material anytime and anywhere, by utilizing information and communication technology as a means of implementing learning.

The discovery learning model is a treatment of the learning process by using a pattern of scientific methods to find problem-solving by students in study groups with steps through simulation, identification, data collection, verification so that they are able to draw conclusions [5]. Guided Discovery Learning Model), which is a process of learning that requires the teacher's role as a facilitator [6]. Good learning is to mix and match the role of ICT in understanding concepts to solve problems [7].

Mathematical material and mathematical reasoning are two things that can not be separated, namely mathematical material understood through reasoning, and reasoning

understood and trained through learning mathematical material if the ability to reason is not developed then mathematics for students will only be considered mere arithmetic [8].

Improve students' mathematical reasoning abilities. through the interesting and practical quality of mathematics learning, it is necessary to support visual learning media that are able to clarify and be abstract so that it leads to contextual learning processes [9]. Utilization One of the media based on Information and Communication Technology in the learning process can help the process of mathematical reasoning that is easily found by educators [10]. The application of the discovery learning model is poured on instructional media based on information technology and communication will be able to improve students' mathematical reasoning.

Efforts to improve students' mathematical reasoning abilities in this case researchers try to integrate/combine discovery learning media with computer-aided media technology using Macromedia flash applications, the reason researchers conducted this research to obtain learning media based on discovery learning models that are valid, practical and effective to improve students' reasoning abilities.

2. Methodology

This research is a development study using a 4-D development model, covering 4 stages namely defining, designing, developing and disseminating at the disseminate stage, not because of time constraints. The research was conducted at Istiqlal Deli Tua Private Vocational School, which is one of the Vocational high schools in Deli Serdang Regency, North Sumatra, Indonesia. The subjects in this study consisted of two classes of class X students of the Multimedia Department in the 2018/2019 school year, totaling 72 students. The object of this research is learning media that is developed based on discovery learning models. The process of the research stages can be seen in Figure 1.

The product produced in the development of learning media based on discovery learning. The instruments used in this study were tests and questionnaires. The test is used to measure students' mathematical reasoning abilities. Learning media are of high quality if they meet three aspects that are valid, practical, and effective. Learning media are declared valid based on the results of the assessment of experts as many as (n) people on an item in terms of the extent to which the items represent constructs that are measured using formulas;

$$V = \sum s / \left[n(c-1) \right] \quad [11]$$

Table 1. Category of Validity of Learning Media Based on Discovery Learning Model

No	Achievement	Category
1	≥0.6	Valid
2	<0,6	Invalid

If you have a valid level of validity the value of the level of achievement must be≥ 0.6. If the validity level is below <0.6 the category is invalid then the revision of the media improvement is based on input from the validator. Revisions are made until a valid learning media is obtained.

Learning media are said to be practical media that must be tested and data obtained from experts/practitioners in all aspects analyzed are measured using formulas;

$$\text{Practicality} = \frac{\sum \text{the score of each item}}{\sum \text{ideal score of the item}} \times 100\ \% \quad [12]$$

Table 2. Category of Trial Practical Media Learning 0f Line Materials nnd Runs

No	Achievement Level (%)	Category
1	90 - 100	Very practical
2	80 - 89	Practical
3	65 - 79	Practical enough
4	55 - 64	Not Practical
5	0 - 54	Not Practical

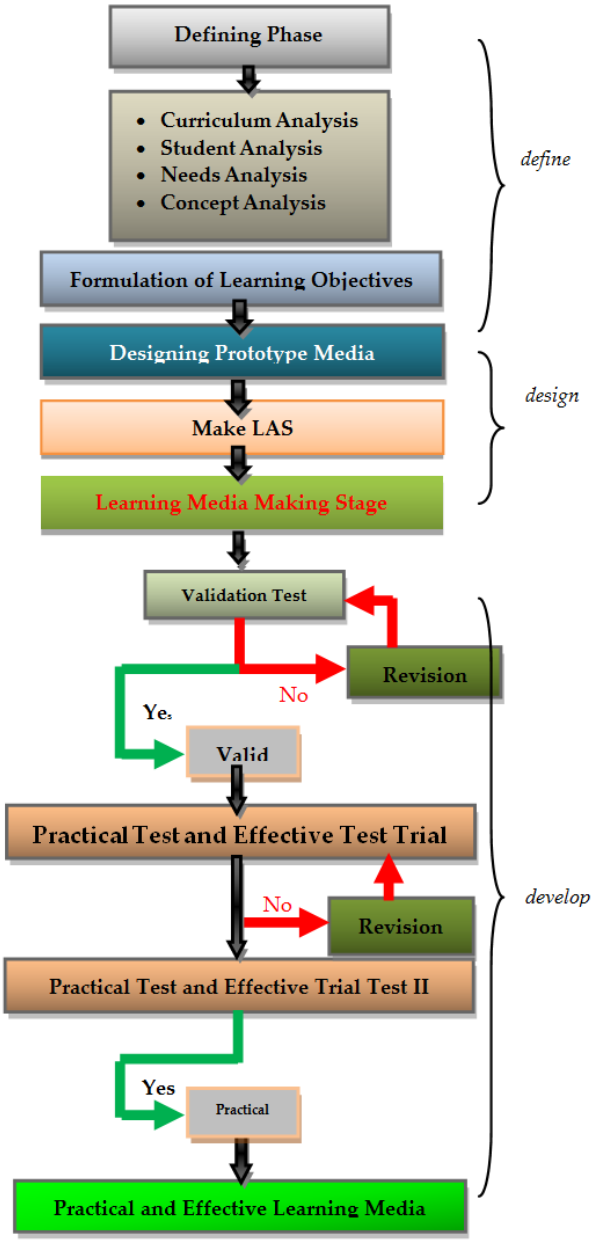

Figure 1. 4-D Development Stage Research Process

Learning media is said to be effective, media must be tested and data obtained from the results of trials in all aspects analyzed are measured by fulfilling several processes, namely:

2.1. Achievement of Student Learning Completeness

Table 3. Criteria of Completion of Student Learning by Permendikbud No. 104 In 2014 [13]

Student Mastery Grades	
Number Range	**Alphabet**
3,85-4,00	A
3,51-3,84	A-
3,18-3,50	B+
2,85-3,17	B
2,51-2,84	B-
2,18-2,50	C+
1,85-2,17	C
1,51-1,84	C-
1,18-1,50	D+
1,00-1,17	D

Table 4. Classification Of Student Learning Power

No	Value Interval	Information
1	$0 \leq NKP < 54$	Very low
2	$54 \leq NKP < 65$	Low
3	$65 \leq NKP < 79$	Medium
4	$79 \leq NKP < 89$	High
5	$89 \leq NKP < 100$	Very high

Note: NKP = Reasoning Ability Value

2.2. Student Responses

Student response is a positive response of students to the media developed, given a questionnaire student responses after completion of learning using the media. Data obtained using Guntman scale 1 and 0, where the value of 1 for the criteria for positive answers and the value of 0 for the criteria for negative answers, with the following formula:

$$PRS = \frac{\sum A}{\sum B} x100\% \quad [14]$$

Where:

PRS: Percentage of many students who responded positively

$\sum A$: The Proportion of students who voted

$\sum A$: Number of students (respondents)

3. Result and Discussion

The product of this research is Discovery Learning-Based Learning Media. Data collection instruments in this study were the Learning Implementation Plan (RPP), Student Activity Sheet (LAS) and mathematical reasoning test instruments. The results obtained at each stage of 4-D development are presented as follows:

3.1. Stage of Definition

At this stage, the curriculum analysis begins with the preparation of a learning implementation plan in accordance with the learning achievement competencies. Analysis by the teacher to class X students of Istiqlal Delitua Vocational School on the mathematical reasoning ability and the learning independence of students consisting of 36 students obtained the results of observations showing information that student reasoning is low on each indicator of reasoning on the sequence material and the sequence. Analysis of teacher and student needs for the media can be concluded as follows; (1) 81.81% of teachers and students stated that they did not use instructional media in the process of learning mathematics in class, and only 18.18% of teachers and students used instructional media, (2) as much as 95.45% of teachers and students still used media that are less interesting and monotonous for learning mathematics in class, (3) amounting to 93.18% of teachers and students are not familiar with learning media using Macromedia Flash and only 6.81% of teachers and students who know learning media using Macromedia Flash.

3.2. Stage Design

At this stage, the learning device is in the form of a prototype (for example learning media) using discovery learning models where at the beginning of learning students observe a problem given at each meeting, Student Activity Sheets (LAS) consist of 4 sets for 4 meetings. LAS is a place to write answers according to procedures with reasoning indicators obtained in groups based on the problems given to the LAS where the correct answers can be checked and displayed on the media. The LAS provides workmanship instructions, a place to write the names and answers for each problem contained in the LAS, and the creation of learning media Macromedia flash based on discovery learning models of sequential material and series uses the Macromedia Flash 8 application from the intro to the cover. Before the learning media product is tested, the media is validated by experts who will assess the validity of learning media based on Macromedia flash discovery learning models, namely media experts and material experts.

3.3. Development Stage

The results of the definition and design produce an initial design of instructional media called a draft media I. The first procedure for development is to validate the learning media in the draft media I to the expert /experts and then field trials are conducted. The results of validation by experts/experts in the form of validation values, criticisms, and suggestions are used as a basis for revising and perfecting the learning media developed. Revised learning media are learning media that do not meet valid criteria and are hereinafter referred to as step II.

At this stage, draft media I was tested for validity. The goal is to see weaknesses in the draft media so that it can be revised and perfect the material about the graphics of learning media developed. The results of the validation by the expert/expert in the form of construct validity

assessment show that from the expert/media expert's assessment of the assessment indicators the feasibility of the contents of the learning media meets the validity criteria, and the indicators of the media graphic assessment meet the validity criteria of the two assessment indicators conclude that the validation of the learning media by the expert/experts that the media can be used with improvements.

The expert/material expert evaluation of the assessment indicators of the feasibility of the contents of the learning material meets the validity criteria, and the assessment indicator of the presentation of the learning material meets the validity criteria and the assessment indicators of language and graphics meet the validity criteria of the three assessment indicators conclude that the validation of learning media by experts/experts that the material learning can be used with improvement. Hereinafter referred to as step III.

At this stage, the revised media draft I based on expert/expert input was tested on the subject class of this study to see the practical and effective learning media developed, this process is called experiment I. The aim is to see weaknesses in media draft I so that it can be revised and perfecting the material, the results have not shown the accuracy of students' mathematical reasoning abilities and the practical and effective use of learning media. After the revision is complete, experiment II is conducted to perfect or determine that the media is already practical and effective to use, and is able to improve students' mathematical reasoning.

3.3.1. Test the Validity of Learning Media

Table 5. Results of Validation By Expert/Media Expert and Learning Material

Indicators of assessment by experts/Instructional media experts		
Rating Indicator	Value of Validity Results	Category
The feasibility of the contents of the learning media	0,85	Valid
Learning media graphics	0,85	Valid
Indicators of assessment by experts/learning material experts		
Rating Indicator	Value of Validity Results	Category
The feasibility of the contents of the learning material	0,79	Valid
Presentation of learning material	0,78	Valid
Linguistic and graphic	0,81	Valid

Trial I Learning Media

3.3.2. Practicality

Based on the results of the trial I obtained criteria for developed learning media. Regardless of aspect.

The practicality of instructional media is obtained from the results of observations of the implementation of learning, assessment by the teacher. The practicality of the results of observing the implementation of learning is met if it reaches the minimum category that is Practical. The results of trial I on the implementation of learning media are presented in Table 6:

Table 6. Result of Trial I Practicality of Learning Media

Assessment Aspects	**Average**	**Category**
Syntax	75,8%	Practical enough
Social system	75,8%	Practical enough
Principles of Management Reaction	87,5%	Practical
Total	**79,7%**	**Practical enough**

Based on the results of the trial I obtained an average value of the implementation of trial I was 79.7. This corresponds to the practicality category at a fairly practical level, this means that the level of practicality of instructional media in trial I have not yet fulfilled its practicality/ease of use. Then the next test must be carried out.

3.3.3. Effective

The results of the effects test in the first trial of the learning media developed are; (a) Description of the results of students' mathematical reasoning abilities, (b) mastery of reasoning abilities, (c) Classical Completion of Mathematical Reasoning Capabilities, can be seen in Table 7 as follows:

a. Learning process

In the learning process in class, students are less conducive because in groups only use one computer for discussion. Whereas each student can hold one computer to study.

b. Description of the results of students' mathematical reasoning abilities

A description of the results of students' mathematical reasoning abilities in the first try is shown in Table 7 below:

Table 7. Description Of Results Of Mathematical Reasoning Students At Trial I

	Pretest Value Results	**Predicate**	**Postest Value Result**	**Predicate**
The highest score	71,88	B	81,25	B+
Lowest Value	45,31	C-	53,13	C
Average	57,47	C+	67,19	B-

The data shows that the average mathematical reasoning ability of students in the pretest results is 57.47 and in the posttest results is 67.19. If categorized based on the level of mastery of students, the level of mastery of mathematical reasoning abilities of students on the results of the first test post can be seen in Table 8.

c. Mastery of students' reasoning abilities

Table 8. Level of Authority of Postest Material Ability in Trial I

Value Interval	**Total students**	**Percentage**	**Category**
$0 \leq NKP < 54$	1	2,78%	Very low
$54 \leq NKP < 65$	15	41,67%	Low
$65 \leq NKP < 79$	19	52,78%	Medium
$79 \leq NKP < 89$	1	2,78%	High
$89 \leq NKP < 100$	0	0%	Very high

Note: NKP = Reasoning Ability Value

From the results of student learning in the first try, it is known that students who get the very low category are 1

student (2.78%), the low category is 15 students (41.67%), the medium category is 19 students (52.78%), the high category was 1 student (2.78%) and there were no students who received the very high category. Meanwhile, based on the level of completeness in the classical mathematical reasoning ability of students in the first try can be seen in Table 9.

d. Classical completeness of students' mathematical reasoning abilities

Table 9. Level of Classical Completion of Student Material Reasoning Ability in Trial I

Category	Mathematical Reasoning Ability of Students	
	Total students	Percentage
Complete	28	77,78%
Not complete	8	22,22%
Total	36	100%

Data Table 9 above shows that as many as 8 students (22.22%) did not complete, while students who completed the mathematical reasoning ability test were 28 students (77.78%). From the results of classical students' completeness, it can be concluded that the mathematical reasoning ability of students achieving completeness classically is less than 85% namely 77.78% so that the effective category seen from classical completeness has not been fulfilled.

Trial II Learning Media

3.3.4. Practicality

Based on the results of the revision of the trial I criteria developed learning media. Coa II test was conducted to meet the practicality criteria of instructional media obtained from the results of observations of the implementation of learning, assessment by the teacher. The practicality of the results of observing the implementation of learning is met if it reaches the minimum category that is Practical. The results of Trial II on the implementation of instructional media are presented in Table 10:

Table 10. Test Results II Practicality of Learning Media

Assessment Aspects	81,1%	Practical
Syntax	84,1%	Praktis
Social system	90,5%	Very practical
Principles of Management Reaction	85,2%	Practical
Total	**81,1%**	**Practical**

Based on the results of the trial II assessment of the 3 aspects obtained an average percentage value of the syntax aspect of 81.1% with the category of "practical", the percentage of aspects of the social system that is 84.1% with the category of "practical" and the percentage of aspects of management principles is 90,5% with the category "very practical". So that the total average of the three aspects is 85.2% with the category "practical".

3.3.5. Effective

The results of the effectiveness of the second try out of the learning media developed were; (a) learning process, (b) Description of the results of students' mathematical reasoning abilities, (c) mastery of reasoning abilities, (d) Classical Completion of Mathematical Reasoning Ability, can be seen in Table 7 as follows:

a. Learning process

In the learning process in class, the students are less conducive because the learning media application no longer has to use a computer but can also use a smartphone.

b. Description of the results of students' mathematical reasoning abilities

Descriptions of increasing students' mathematical reasoning abilities by using learning media based on discovery learning models in trial I and trial II are shown in Table 11 below:

Table 11. Description of Results of Mathematical Reasoning Students At Trial II

	Pretest Value Results	Predicate	Postest Value Result	Predicate
The highest score	76,56	B	92,19	A-
Lowest Value	51,56	C	71,88	B
Average	61,63	C+	83,29	B+

The data shows that the average mathematical reasoning ability of students in the pretest results is 61.63 and in the posttest results is 83.29. If categorized based on the level of mastery of students, the level of mastery of mathematical reasoning ability of students on the results of the post-test II trials can be seen in Table 12.

c. Mastery of students' reasoning abilities

Table 12. Level of Power of Postest Material Ability In Trial II

Value Interval	Total students	Percentage	Category
$0 \leq NKP < 54$	0	0%	Very low
$54 \leq NKP < 65$	0	0%	Low
$65 \leq NKP < 79$	9	25%	The middle
$79 \leq NKP < 89$	18	50%	High
$89 \leq NKP < 100$	9	25%	Very high

Note: NKP = Reasoning Ability Value

From the learning outcomes of students in the second trial, it was found that students who received the medium category were 9 students (25%), the high category was 18 students (50%), the very high category was 9 students (25%) and there were no students who received the category low and very low. Meanwhile, based on the level of completeness in the classical mathematical reasoning ability of students in the second trial can be seen in Table 13.

d. Classical completeness of students' mathematical reasoning abilities

Table 13. Level of Classical Completance of Mathematical Reasonability of Students in Trial II

Category	Mathematical Reasoning Ability of Students	
	Total students	Percentage
Complete	36	100%
Not complete	0	0%
Total	36	100%

From Table 13 above it is known that all students (100%) complete in completing tests of mathematical reasoning ability. From the results of classical students' completeness, it can be concluded that the mathematical

reasoning ability of students achieving completeness classically is more than 85% so that the effective category seen from classical completeness has been fulfilled.

Description of Results of Improving Student Material Reasoning Abilities

Descriptions of increasing students' mathematical reasoning abilities by using learning media based on discovery learning models in trial I and trial II are shown in Table 14 below:

Table 14. Description of Results of Improving Student Material Reasoning Abilities

N-Gain Range	Category	Number of Students (Trial I)	Number of Students (Trial II)
0,7-1,0	High	0	10
0,3-0,69	Medium	11	22
0-0,29	Low	25	4
Total		**36**	**36**

The table above shows that the number of students who experienced an increase in the low category in trial I was as many as 25 students (69.44%) and in trial II it became a little that is 4 students (11.11%) then for the moderate category in trial I there was as many as 11 students (30.55%) and in the second trial increased the number to 22 students (61.11%) while for the high category there were no students who received the high category in trial I but in trial II there were 10 students (27,78%) who get high n-gain. For more details can be seen in Figure 2 below:

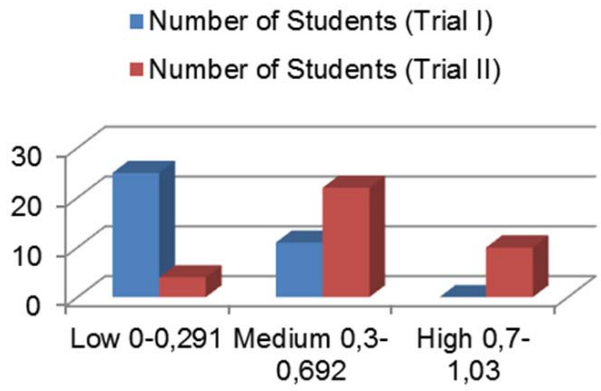

Figure 2. Categories of Increased Mathematical Reasoning Capability For Each Trial

It can be concluded that students' mathematical reasoning in each trial has increased from the application of learning media based on discovery learning models. The use of instructional media developed has an impact on increasing (n-gain) students' mathematical reasoning abilities.

4. Discussion

4.1. Quality of Macromedia Flash Learning Media Developed Based on Discovery Learning Models

Macromedia flash learning media based on discovery learning models developed is also said to be feasible based on evaluators from all aspects by 3 media experts and 3 material experts. Macromedia flash learning media based on discovery learning models developed is also said to be feasible based on all aspects of 3 media experts and 3 material experts. So it can be concluded that learning media based on discovery learning Macromedia Flash developed has met the validity criteria.

The assessment data from the results of the practicality questionnaire conducted on each trial to obtain the total percentage of all aspects for the first trial of 79.7% with the category is still quite practical. Then conducted again for the second trial, the percentage of practicality to 85.2% with the practical category.

Based on the results of each trial, the learning media developed have met the effective criteria after being carried out until the second trial in terms of classical student completeness, student responses and learning time. The results of the first trial obtained the percentage of students who completed only 77.78% for the ability of reasoning, therefore the second trial was conducted.

In the second trial, students 'reasoning ability was 100% complete, learning independence for all indicators was high, students' responses were positive with a percentage of 86.70% and the learning time did not exceed the time that was made in the lesson plan.

Based on the explanation of the above research results, it can be concluded that the use of Macromedia Flash learning media based on the discovery learning model developed has met the effective criteria.

4.2. Improved Students' Mathematical Reasoning

Based on the analysis of reasoning ability tests in the first and second trials it was concluded that the students' mathematical reasoning in each trial experienced an increase in the application of learning media based on discovery learning models. Increased reasoning ability is seen from the n-gain value of each student. Where the n-gain value is obtained in the first trial, there are no students who get high n-gain, while in the second trial, there are 10 people who get high n-gain. So it can be concluded that the use of learning media developed has a positive impact on the increase (n-gain) of students' mathematical reasoning abilities.

5. Conclusions

Based on the results of this study, it was concluded that the learning media based on the discovery learning model has been tested to meet valid, practical, and effective criteria and is able to improve students' mathematical reasoning.

Through the findings of this study, proving that learning media based on discovery learning models is important for teachers to consider efforts to maximize student learning outcomes through learning media based on discovery learning models developed.

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