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Mathematics-Based Development Module Guided Discovery Model to Improve Creative Thinking Ability

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Abstract: *Creativity is one of the abilities students must possess in learning mathematics. This study aims to produce mathematical modules based on discovery models guided by arithmetic rows and series for students of class X SMK. This research is a 4D model development research consisting of four stages: define, design, develop, disseminate. Research subjects included media experts, material experts, students from 2 schools in 2 Muhammadiyah Vocational Schools in Yogyakarta and Cangkringan Muhammadiyah Vocational Schools. Data collection techniques in the form of questionnaires and tests. The research instrument is a questionnaire that has been reviewed. Data analysis techniques used qualitative analysis which was changed to a cumulative Likert scale. The results of the material feasibility test were in a very good category with an average score of 107. The results of the module media feasibility test were in the very good category with an average score of 98.33. While the results of the student response questionnaire on the trial of small class products included in the good category with an average score of 92.33. And the results of student responses to the trial of large class products are included in the good category with an average score of 91.45. So the mathematics module based on guided discovery models on sequence and sequence series material.*

Keywords: *Modules, Sequences, and Guided Discovery Series, Creative Thinking*

INTRODUCTION

Creativity is a flexible, smooth, unique and unusual thinking in different situations in Turkmen (2015). Senemoğlu (2013) defines creativity as providing unique responses; flexibility as the ability to adapt to changing conditions; and fluency as a quick sorting of ideas. Creativity is one of the abilities needed to solve problems. Creativity is needed for science, technology, and art that covers everyday life (Runco, 2014) Creative thinking is considered the ability to generate original ideas or answers (Duff et al, 2013) and to see new and unexpected relationships or factors that are not related (Piawa, 2010). Mumford (2003) notes that identifying and defining important influence problems in creative performance. Guilford and Hoepfner (1971) state that creative people are sensitive to the existence of problems and that individuals have few opportunities to show creative traits without problems to solve. Although Runco (2003) asserts that creativity is very helpful in solving problems, he believes that creativity has other goals as well. Lemon (2011) also notes that creativity is multifaceted. However, the ability to solve student problems in Indonesia is still low. Based on the latest PISA 2015 results, Indonesia is ranked 62nd out of 70 countries (OECD, 2018). As for the 2015 TIMSS results on Indonesian mathematics ranked 46th out of 51.

Based on several studies conducted, effective modules for teaching students' creative thinking skills (Aryani, et al: 2016, Festiana, et al 2014). This is in agreement with Devesh and Nasseri (2014) who suggested using the module as a strategy to improve mathematics learning outcomes. The module is one of the learning resources used to facilitate students in understanding the material and achieving learning goals. According to Perdana (2017), the module is a teaching medium that can be used by students to study independently with minimal help from others. The learning process that uses modules requires students to better understand the material because students are directly involved in finding the concepts to be learned so that students do not just memorize them. In order for students to better understand this concept and

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material, the effort that can be done is to use a learning method that invites students to find and find out for themselves the formulas or concepts that will be studied. One of them is by using guided discovery learning methods.

Discovery learning models are one that provides opportunities for students to find information without the help of teachers (Saab et al., 2005). This model is known as a guided discovery method, in which students are guided to find solutions to problems (Klahr & Nigam, 2004). Discovery learning is proven to improve the quality of learning compared to conventional methods and can improve their knowledge during the learning process (Martins & Oyebanji, 2000; Bajah & Asim, 2002). The guided discovery model is purposely designed to improve students' activeness larger, process-oriented, to find their own information required in achieving the learning goals (Yuliani and Saragih, 2015). Discovery learning model is a series of learning activities that emphasize the process of critical thinking and analysis to reach and find their own answers to the problems being asked. The essence of discovery learning is to give students lessons to deal with problems faced by students facing the real world (Martaida, 2017). The steps of the discovery learning model are 1) preparation steps, 2) implementation. The benefits of discovery learning processes are: 1) increasing intellectual potential, 2) shifting values from extrinsic to intrinsic, 3) increasing long-term performance, 4) learning heuristics from findings (Bruner 1997). The main target of the discovery learning model is maximum student involvement in teaching and learning activities and developing confidence about what is found during the learning process.

Hernandez et al. (2011) emphasize that discovery methods can help learn various problem-solving strategies, transfer cognitive data to be more useful, and know how to start learning. Ooi et al. (2011) show that it is possible and more important to help an individual find concept, even though the discovery process is not fully realized. Guided discovery instructions focus on guiding on finding oneself. In the process, Peng et al. (2011) consider the main constraint as psychologically assuming that one cannot find. Two unfavorable habits of attitude are shown to influence discovery learning; some are lazy to think and about the impossibility of discovery, and the second is about discovery as giving only a glimpse of things (Shieh, 2016). Two such learning attitudes largely inhibit the effects of guided discovery instruction. Hong et al. (2011) argued that a person, looking for rules and relevance in a learning environment, must grasp the hope of exploring certain things or reminding others of such expectations to find out various methods of excavation (Teo, 2011). Ozkan & Kanat (2011) show six elements for learning by being guided.

The material in this study is sequence and series. Rows and series are one of the concepts that use formulas or procedures in solving math problems. Fauziah, et al (2017) students have difficulty using concepts that exist in rows and rows when most students only memorize formulas. Mathematics learning outcomes of arithmetic sequences and series are still low, one of the factors that influence them is the inappropriate strategy so that learning is not optimal. In addition, students do not understand the sequence and series of material presented by the teacher because the examples presented are not experienced directly by students (Khulinah, 2015).

This article aims to analyze the material to be developed in teaching materials in the form of modules based on guided discovery models, to describe and develop guided discovery-based mathematics modules that can improve creative thinking skills. This article is written in a systematic manner presenting the second part of the introduction describing the third method of research describing the results of the discussion and the fourth provides a conclusion.

RESEARCH METHOD

4D Model used to develop mathematical modules based on guided discovery models that can improve the ability to think creatively and confidently. The stages of the 4D model are the defining stage, the stage of designing the developing phase and the disseminating stage of Thiagarajan, Semmel, & Semmel (1974: 5-9). This procedure is presented in Figure 1

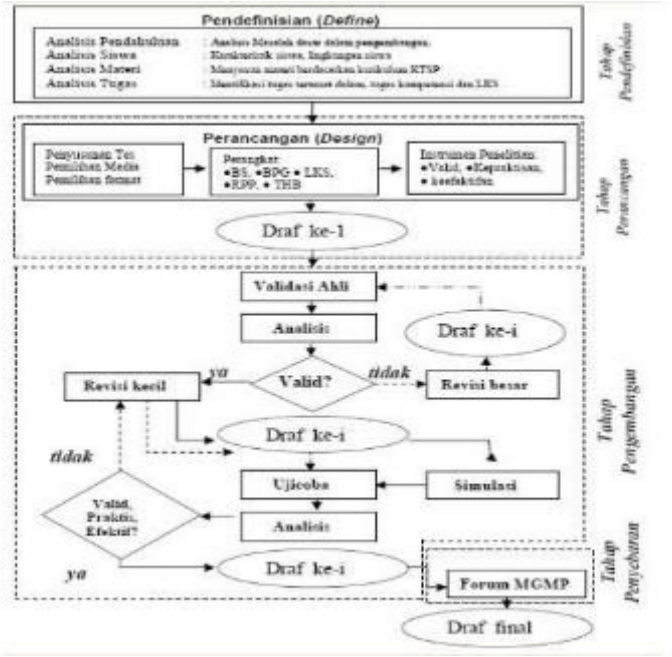

Figure 1 General steps in Research and Development

In the define phase, researchers conduct material analysis, curriculum analysis, student analysis, analysis of learning objectives. Then the design phase of the researcher designed the module developed. Furthermore, the development stage researchers conducted product validation and tested it in Muhammadiyah 2 Yogyakarta Vocational School and Cangkringan Muhammadiyah Vocational School.

The instruments used were interview interviews and questionnaire guidelines. Data analysis techniques used were analyzing each questionnaire item, both questionnaires of material experts, media experts, and quantified student responses.

DISCUSSION

This study uses the 4D model (Define, Design, Develop, Disseminate). The first stage is defined which aims to determine and define learning conditions. The stages in the definition include analysis of the initial stages, student analysis, material analysis, task analysis and formulation of learning objectives.

The initial analysis phase, obtained the results in the form of curriculum analysis of mathematics subjects sequence and series material for students of class X SMK which refers to the 2013 curriculum includes identification of Core Competencies, Basic Competencies, subject matter, learning activities, assessment, time allocation, and learning resources used. The results of curriculum analysis are listed in the mathematics syllabus on the subject matter of the sequence and series that are available in the 2013 curriculum. The basic competencies contained in the syllabus are translated into indicators of achievement of competencies. This

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indicator is a reference for module construction. The Basic Competencies found in the sequence and series material are in Table 1:

Table 1 Basic Competencies Basic

No	Competencies
3.5	Analyzing arithmetic ranks and series
4.5	Resolving contextual problems related to arithmetic sequences and series
3.6	Resolving contextual problems related to ranks and series arithmetic
4.6	Resolving contextual problems related to geometric ranks and series

Based on Table 1 there are 4 Basic competencies that will be used in the module construction. Next, student analysis is carried out. Based on the results of observations on learning activities carried out on students of class X Vocational High School and interviews by teachers obtained the results of the analysis of student characteristics namely low student confidence, seen from students who were still hesitant in answering the questions given by the teacher. Students' creative thinking ability still needs to be improved.

After the analysis of students, the task analysis was carried out. Analysis step of the task used to analyze tasks that must be mastered by students so that competence can be achieved. The assignments are in the form of group assignments, individual assignments that are used to measure students' abilities in sequence and series material.

Formulation of learning objectives. Steps in formulating learning objectives obtained results in the formulation of learning objectives from competency achievement indicators that have been developed previously. The learning objectives are the Purpose Table 2 of the Learning Objective

Table 2 of the Learning Objective

No	Learning Objectives
3.5	Conceptualizing the artistic and sequential lines or sequences through observation and giving reasons.
3.5	Establishing sequence and series patterns and their application in solving simple
4.5	problems Resolving contextual problems related to arithmetic sequences
4.5	Resolving contextual problems related to arithmetic series
3.6	Conceptualize geometric lines and sequences or other lines through observation and reasoning
3.6	Establish row and series patterns and their application in simple problem solving
4.6	Resolve contextual problems related to geometry sequences
4.6	Resolve contextual problems related to geometry series

The second stage designs, which aims to design module developed. The stages in the design include media selection, format selection, initial design. Based on task analysis, concept analysis, and available facilities at school, the selected media is the module. The following view of the initial design of the discovery-based learning module is guided in Figure 2.

Figure 2 Module Design

Formation the development of learning media in sequence and series material includes clarity of work instructions, suitability of the format as a module, suitability of the contents of the module with the desired concept or definition, color harmony, writing and drawing on the module, suitability of the color of the image and writing in the practice of the problem, the suitability of the appearance of images and writing on the material in the sequence and series. As for the initial design referred to in this paper is the design of all activities carried out before the trial is carried out. The results of the initial draft of this module which is draft I

The third stage of development is the realization phase of the module and instrument design used to measure the performance of products that have been developed. There are expert validation, media validation, and testing.

At the expert validation stage, an assessment is carried out to find out the validity of the modules developed. The module that has been approved by the supervising lecturer is then validated by the validator namely material expert lecturers, media expert lecturers, and teachers. Validation of the module uses an assessment instrument that has been reviewed by the lecturer, Mrs. Dwi Astuti, M.Pd, while the instrument in the form of questions and questionnaires is reviewed by Dr. Suprapto. After valid instruments can be used by material experts and media experts to assess the developed modules.

Material experts consist of three people, namely Niken Wahyu Utami, M.Pd. as UPY Lecturer, Amalia Muthia Sayekti, S.Pd. as Mathematics Teacher at Muhammadiyah 2 Yogyakarta Vocational School, Eni Retno Purwanti, S.Pd. as a Mathematics Teacher at Muhammadiyah 2 Vocational School in Yogyakarta. Material experts in this matter did not revise the learning media. However, the material expert is correcting the material to be used in the learning media. The following are some inputs and suggestions from material experts summarized in Table 3

Table 3 Inputs and suggestions from experts on the material

Suggestions and Comments	Follow-up
Taking problems in the formulation of the problem is not yet appropriate. Try searching for a problem that is more fitting	Menganti some issues
Mrs. Ratna should be replaced with the company	has been replaced from Mrs. Charles, a pengarjin batik converted into company- “Jaya Batik”

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The ability to complete the batik should be replaced on the number of requests increases	Already corrected word with patterns that work, at What month did Mrs. Ratna finish 63 pieces of batik cloth changed to what month the company "Jaya Batik" received a request to make 63 pieces of batik cloth The
game of kelerang was distributed instead of compiled	Changing questions from the game of marbles became a problem related to the calendar

Inputs and suggestions from experts were then revised. Furthermore, the feasibility of learning material was assessed by three material experts. The following are the results of the questionnaire's calculation of the feasibility of learning media by material experts shown in Table 4.

Table 4 Results of Questionnaire Calculation Feasibility of Material

Assessors	Position	Score	Criteria for Quantitative Data
Niken Wahyu U., M. Pd.	Lecturer in Mathematics Education UPY	106	Very Good
Amalia Muthia S., S. Pd.	Mathematics study teacher at SMK Muh 2 Yogyakarta	102	Very Good
Eni Retno Purwanti, S. Pd	Teacher in Mathematics study at SMK Muh Cangkringan	113	Very Good
Total		321	
Average		107	Very Good

Based on Table 4, it can be seen that the average score of the assessment of material experts is 107. These results indicate that the learning media developed in terms of material are in the very good category. The media expert consisted of three people, Syariful Fahmi, M.Pd. as the lecturer of multimedia learning courses in Ahmad Dahlan University Mathematics Education, Amalia Muthia Sayekti, S.Pd. as Mathematics Teacher at Muhammadiyah 2 Yogyakarta Vocational School, Eni Retno Purwanti, S.Pd. as a Mathematics Teacher at Muhammadiyah 2 Vocational School Yogyakarta. The following are some input provided by media experts related to the learning material can be seen in Table 5.

Table 5 Inputs and suggestions from media experts

Suggestions and comments on	Follow-up
In cover, delete 2018	Delete 2018
Revise the preface and guideline of module	Move the text Magister of Mathematics Education from the center to below
Add some note in picture and table	Has revised
The sign "=" is not parallel	Has revised
Add some dots in arranging conjectur step	Change the sign "=" to make it not parallel
Change the word *suku ke-10*	Change into*10 suku pertama*
Add the biography of the writer	Has revised

Change the problem in discussion 2 related to stacks of books	Has revised

Feasibility of learning material is assessed by three media experts. The following are the results of the questionnaire calculation of the feasibility of instructional media by the material experts shown in Table 6.

Table 6 Questionnaire Calculation Results Feasibility of Media

No	Appraisal	Position	Score	Criteria for Quantitative Data
1.	Syariful Fahmi, M.Pd.	Lecturer of UAD Mathematics Education	100	Very Good
2.	Amalia Muthia Sayekti, S.Pd.	Teacher in Mathematics study at SMK Muh 2 Yogyakarta	91	Good
3.	Eni Retno Purwanti, S.Pd.	Teacher in Mathematics study at SMK Muh Cangkringan	104	Very Good
Total			295	
Average			98.33	Very Good

Based on Table 6, it can be seen that the average score of the material expert assessment is 98.33. So it can be concluded that the learning media developed in terms of media are included in the very good category.

After the module is validated, the module is tested. Small class trials are carried out in classes containing 5 students. This small class test was conducted in 2 schools, namely Muhammadiyah 2 Yogyakarta Vocational School and Cangkringan Muhammadiyah Vocational School. This small class trial was conducted to determine the level of student response and input from students before being used in the usage test. Test class from students before being used in usage tests. Small class trials were carried out after the module was repaired in the previous stage. The purpose of this small class test is to get response and input in class. The trial was carried out by providing learning media products that were developed and students were asked to fill out an assessment questionnaire and provide comments and suggestions.

The implementation of a small class trial was conducted on February 7, 2018, involving 6 students of Muhammadiyah 2 Yogyakarta Vocational School and on February 3, 2018, involving 6 students of Cangkringan Muhammadiyah Vocational School. The selection of students for small class trials is done by the teacher concerned because they better understand the character of students. At this stage, there is no input from students on learning media, so the next stage can be implemented.

Students' responses to the developed learning media were known from the results of student assessment through distributed questionnaires and were filled out during small class trials and usage trials. The results of the questionnaire assessment are used as input for revising the learning media before using the trial.

Table 7 Calculation Results Student Questionnaire Response Trial Small Class

Number	School	Average	Quantitative Data Criteria
1.	SMK Muh 2 Yogyakarta	93	Good
2.	SMK Muh Cangkringan	91.67	Very Good
	Average	92.33	Good

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Based on Table 7, can It was seen that the average score of the assessment of students' responses in the small class trial was 92.33, so that based on the guideline table the assessment criteria of learning media from the student response aspects were included in the Good category

Table 8 Calculation Results Student Questionnaire Response Trial Usage

Number	School	Average	Quantitative Data Criteria
1.	SMK Muh 2 Yogyakarta	96.45	Very Good
2.	SMK Muh Cangkringan	86.45	Good
	Average	91.45	Good

Based on the table above, it can be seen that the average score of the assessment results of students' responses to the use trail is 91.45 so that based on the guidelines table the assessment criteria of learning media from the student's response aspects are included in the Good category.

The fourth stage is Desiminating. At this stage, products that have been developed and have fulfilled the criteria for feasibility and effectiveness are given to Muhammadiyah 2 Yogyakarta Vocational Schools and Cangkringan Muhammadiyah Vocational Schools.

CONCLUSION

Mathematical module materials based on guided discovery models are sequences and series. The design used in making the module using Corel Draw and Microsoft Word 2016. The results of the material feasibility test in the category are very good with an average score of 107. The module media feasibility test results are a very good category with an average score of 98.33. While the results of the student response questionnaire on the trial of small class products included in the good category with an average score of 92.33. And the results of student responses to the trial of large class products are included in the good category with an average score of 91.45. So the mathematics module based on guided discovery models in the sequence and series material is worthy of use.

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