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Development of “OQALE” Based Reference Module for School Geometry Subject and Analysis of Mathematical Creative Thinking Skills

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Abstract. This research aims to develop an OQALE based reference module for school geometry subject that meets the criteria of a valid and practical. OQALE approach is learning by of O = observation, Q = question, A = Analyze, L = Logic, E = Express. Geometry subject presented in the module are a triangle, the Pythagorean theorem, and rectangular. Mathematical skills of creative thinking shown from four aspects: fluency, flexibility, originality and elaboration. Research procedures in the development of reference module using a strategy of the investigation and development described by [2], which is limited to the sixth stage is leading field testing. The focus of this research is to develop a reference module that is valid, practical and able to increase the mathematical creative thinking skills of students. The testing is limited to three teachers, nine students and two mathematic readers using purposive sampling technique. The data validity, practicality, and creative thinking skills upgrading collected through questionnaires, observations, and interviews and analysed with a valid test, practical test, gain test and qualitative descriptive. The results were obtained (1) the validity of the module = 4.52, which is $4.20 \leq V_m < 5.00$ included in the category of very valid; (2) the results of the questionnaire responses of teachers = 4.53, which is $4.20 \leq R_g < 5.00$ included in the category of very good; (3) the results of the survey responses of students = 3.13, which is $2.80 \leq R_{pd} < 3.40$ included in the category of good with an average percentage of 78%; and (4) increasing skills of creative thinking mathematically nine students through the test of the gain included in the high and medium category. The conclusions of this research are the generated OQALE based reference module for school geometry subject is valid and practical.

1. Introduction

In the sphere of education schooling, mathematics is one of the subjects were considered to have a significant role because math can improve the knowledge of students in logical thinking, rational, critical, thorough, effective and efficient. Besides, mathematics also has a significant role in the development of education. Mathematics showed as a basic science for the development of other disciplines. But unfortunately, mathematics is still regarded as a scourge for students. They assume that math is complicated and abstract. But in fact, math is very close to our daily lives.

The goals of national education is to develop the ability, character, and creative potential [17]. Therefore, the ability and creative thinking skills must also be owned by every student in the mathematics learning. Mathematics requires logical reasoning, efficient and has a vocabulary of ideas



and creative patterns and fantastic. Therefore, mathematics is often called the art of creative thinking [4]. Creativity is the ability to think about things in a new way and unusual and produce a unique solution to a problem [15]. Creativity can be measured by four criteria, namely; (1) fluency; (2) flexibility; (3) originality; and (4) elaboration [8].

There are some learning subjects that students often difficult to understand or teachers are difficult to explain. The difficulties can happen because of the issues abstract, complicated, or unfamiliar. These problems can be resolved, and it is necessary to develop a book or appropriate teaching materials [3]. One of the subjects mathematics which is considered challenging and abstract by students is geometry. The results of the national exam (UN) in 2012 shows that the average absorption students junior high school in Central Java for the material geometry, especially the Pythagorean theorem, flat figure, and the triangle is still below the mean of the national absorption capacity. That is supported by observations and interviews of researchers in some schools in Semarang city. Based on observations and interview researchers, obtained by the fact that there are still many problems in the learning of mathematics.

Regarding students, most students still have a low level of maturity subjects and the level of seriousness learn less. Most of the students are also difficulties in working on different sample questions given by the teacher when in fact the same concept used. That indicates that the level of creative thinking of students is still small.

Regarding learning resources, existing textbooks are still feeling dull, unattractive and difficult to be understood by students.

The fact, as mentioned above encourage authors to do research development reference module that can be used not only in the classroom but also can be used anytime and anywhere as a reference study. This reference module can also customise the speed of comprehension each student. The module is a book written with the purpose make the students can learn independently [3]. The reference module is a module that content and presentation could be used to obtain information about the science are deep and extensive. This module can also be used by anyone students who need. Learning to use module enables a student who has high speed in learning to be more quickly complete the module compared to other students [3].

Mathematics subject to be presented in a reference module that school geometry items are, (1) triangle, (2) the Pythagorean theorem, and (3) rectangle. The use of this reference module will facilitate the students more interested in learning geometry and increase the mathematical creative thinking skills of students.

Reference module that developed in this study is OQAME based reference module. The OQALE approach is learning by exploration, elaboration, and confirmation. Students are always taken on the atmosphere of O = observation, Q = question, A = analyze, L = logic, E = express. Observation means not only to see but also to read the issues to explore the whole concept to be learned. The question means asking questions about information that is not understood from what observed (exploration) or asking a question to increase the flexibility of information. Analyse means doing experiments, processing information from the results of observing and questioning activities. Logic ways to examine, to associate data with other data to make a conclusion of the analyse events. Express means ideas has compiled to get new ideas.

The development of this module is done to obtain OQALE based reference module of school geometry subject valid and practical. The components of educational products are said to be valid when based on state-of-the-art knowledge or strong theoretical rationale (content validity), and all elements must be associated consistently with each other (construct validity). While the elements of educational products said to be practical if the teacher can consider tools or subject that can be used and easier for teachers and students to use [11].

A module is one form of teaching materials packaged thoroughly and systematically, inside contained a set of learning experiences planned and designed to help students take control specific learning goals (Daryanto, 2013). A module is a complete unit that stands alone and consists of a series

of learning activities which is structured to help students achieve some goals that are formulated specifically and explicitly [10].

To develop a reference module needs to pay attention to the characteristics of the modules include; (1) Self-instruction means enable someone to learn to be independent and does not depend on the other hand. (2) Self-contained means all the necessary learning materials contained in modules so that learners can learn thoroughly. (3) Stand alone means not dependent on teaching materials/other media or should not be used together with educational materials/other media. (4) Adaptive means if the module can adjust the development of science and technology, as well as flexible use in a wide range of hardware. (5) User-friendly means instruction and explanation of information in the module helpful and friendly to the wearer.

According to Regiero [6], thinks is all mental activities that help to formulate or solve problems, make decisions, fulfilling the desire to understand, search for answers, and achievement of meaning. According to Krulik and Rudnick [7], think categorised consists of basic thinking, critical thinking, and creative thinking. According to Saefudin [14], creative thinking is a single unit or a combination of logical thinking and divergent thinking to generate something new. Something new is one indication of creative thinking in mathematics, while the other indications related to logical thinking and divergent thinking. Munandar [8] suggests that creativity can be measured by four criteria, namely; (1) fluency; (2) flexibility; (3) originality; and (4) elaboration. Fluency means fluent in expressing his ideas. Flexibility ways to solve the problem with a variety of different ways. Creativity means creating an innovation with their thoughts. Elaboration means that details the steps to resolve the issue. Mathematical skills of creative thinking showed from psychomotor students through observation and interviews before and after using the reference module.

Learning geometry using the module is also associated with Brunner and Van Hiele learning theory. According to Brunner [12], there are three stages of learning progress are enactive, iconic and symbolic. Learning geometry using a reference module in agreement with Brunner's theory. Learning begins by linking the abstract geometry of subject with concrete objects that exist around the learner. Then the students are invited to visualise it in the form of images. Then the last, students can use mathematical symbols to solve the problems of geometry.

According to the theory of Van Hiele, someone will go through five stages of development thinking in learning geometry. The fifth stage of development think Van Hiele: stage 0 (visualization), stage 1 (analysis), stage 2 (deduction informal), stage 3 (deduction), and stage 4 (rigor).

Furthermore, according to the theory of constructivism [12], learning is an active process of learners in constructing meaning, discourse, dialogue, physical experience in the learning process to a process of assimilation and connecting experiences or information that has been learned. That is in line with the stage OQALE used in modules developed. Through this OQALE stage, learners will be more active in learning to use the module independently.

2. Methods

This type of research is a kind of the investigation and development, namely development of OQALE based reference module for school geometry subject. Development procedure used to research and development strategy described by [2], which includes ten steps. It will be taken to six level, namely; (1) research and information collecting; (2) planning; (3) develop a preliminary form of the product; (4) initial field testing; (5) elemental product revision; (6) main field testing.

Stage 1: Research and information collecting, analysing problems in learning mathematics, explaining the characteristics of students (creative thinking mathematically students), examining geometry subjects, investigating difficulty in learning geometry, literature reference module development, literature OQALE approach, and writing creative thinking mathematically.

Stage 2: Planning, conducted targeting reference module, determination subjects, a decision the purpose of learning using a reference module, the selection of the reference module format, and resolution components of the reference module.

- Stage 3:** Develop a preliminary form of product, done the preparation module (draft 1) and instruments of research.
- Stage 4:** Preliminary field testing, validation module (draft 1) and tools of research. Validation module is carried out by the three-person team of experts that are Supervisor 1, Supervisor 2, and a Lecturer in the Mathematics Department, Universitas Negeri Semarang while the instrument validation study carried out by supervisor 1 and supervisor 2.
- Stage 5:** Main product revision, revised module (draft 1) into a module (draft 2) and all the instruments that have been made based on advice from experts. This revision continues to obtain the module (draft 2) and valid instrument
- Stage 6:** Main field testing, conducted testing limited to 3 teachers, nine learners, and two mathematic readers to determine the practicality of the reference module. At this stage used instruments are questionnaire responses of teachers, questionnaire responses of students, and interview guide (for teachers, and mathematic readers). At this juncture also made observations of creative mathematical thinking skills of students before and after using the reference module.

To determine the validity of the reference module used instrument module validation. Besides, it can ascertain that the practicality of the reference modules used instruments questionnaire responses of teachers, questionnaire responses of students, and an interview guide. Meanwhile, it can determine the increase of mathematical creative thinking skills used guidelines observation skills.

The validation module reference calculated by the average score of each aspect indicators from the response of teachers and students [5].

Skills upgrading calculated using normalised gain by the following formula.

$$g = \frac{A - B}{S - B} \times \frac{S}{r}$$

g are a normalised gain. Criteria gain according to Hake [18] presented Table1.

Table1.CriteriaGainIndex

Gain Index	Criteria
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Medium
$g < 0.3$	Low

3. Results

3.1 Research and Information Collecting

This stage obtained information and theories relating to the development of OQALE based reference module for school geometry subject (triangle, the Pythagorean theorem, rectangle), and mathematical creative thinking skills. These theories will help researchers to plan the development of a reference module.

3.2 Planning

OQALE based reference module consists of three sub-modules: module 1 triangle, module 2 Pythagorean theorem, and module 3 rectangle. The purpose of learning using a reference module that understands the material and improves the skills of creative thinking mathematically. Format reference module uses OQALE approach will help students learn from observing, questioning, analysing, logic, and expressing. Through a series of stages this OQALE, students will also be able to increase the mathematical skills of creative thinking with fluence thinking, flexible thinking, original thinking, and elaboration thinking. The validity of this reference module obtained through the stages of preliminary

field testing and primary product revision. On stage initial field testing received validation expert and the reference module improvement suggestions from the experts.

Primary field testing was conducted to determine the practicality, usability, and legibility of module in the field. Data practicality reference module is obtained based on the response of teachers, students, and mathematic readers in the area. The design components of OQALE based reference module for School geometry subjects contain: 1. The initial part consists of a cover "Modul Geometri Sekolah Berbasis OQALE", preface, guide the use of modules, table of contents, apperception, and a map of the module concept, and 2. The contents consist of the subjects presented in the module reference. Part of the substance of a reference sub-modules, comprising:

- a. Map of sub-module concept contains the concepts of the subject to be learned from each sub-module and the relationship between the concepts presented.
- b. InfoMath, in the form of information about the figures of mathematics, history of math and other information.
- c. Description of the subject, which presented with a simple sentence.
- d. Example question, in the form of questions.
- e. You can do it, in the form of questions that test the ingenuity of students in solving a mathematical problem.
- f. Summary, containing the main points of discussion in the submodules that completed studied.
- g. Exercise matter includes questions to test the ability of students to understand the material they have learned.
- h. Test formative contains questions to measure the subject understanding of specific sub-modules.
- i. References.
- j. Efforts to follow up is used to determine the level of mastery learners after taking the test formative.
- k. Key answers developmental tests, such as formative test answers.

3.3 Develop Preliminary Form of Product

At this stage of the preparation of the reference module (draft 1) includes; the sheet of module validation; questionnaire responses of teachers; questionnaire responses of students; guidance teacher interviews; leadership student interviews; guidance mathematic readers interviews; the scoring guidelines mathematical creative thinking skills; and the sheet of instrument validation.

At this stage, the reference module has been through the validation and repeated revisions based on suggestions from the supervisor

3.4 Preliminary Field Testing

At this juncture, validation module reference (draft 1) and instruments of research. Results of the validation module obtained an average assessment module by an expert third validator included in the category of very valid, namely $V_m = 4.52$ (maximum score 5). So that OQALE based reference module for school geometry subjects said to be valid. Results of the validation module shown in Table 2.

Table 2. Results of Validation Module

The Validity of Module	Validator Value		
	I	II	III
Validity	4.10	4.65	4.80
Criteria	Valid	Very Valid	Very Valid
V_m	4.52		
Criteria V_m	Very Valid		

It is suggested that each validator experts stated that the OQALE based reference module for school geometry subject is correct and may increase mathematical creative thinking skills. Depending on the results of expert validation, obtained recommendation that the module used with minor revisions. This review is done based on the comments and suggestions given by the experts.

Table 3. Results Validation Instrument

Instrument	averageResults ofValidation	Criteria
TeacherQuestionnaireResponse	4.50	VeryValid
Student QuestionnaireResponse	4.42	VeryValid
TeacherInterviewGuidelines	4.50	VeryValid
StudentInterviewGuidelines	4.50	VeryValid
Mathematic ReaderInterviewGuidelines	4.50	VeryValid
GuidelinesObservationSkills	4.17	Valid

Based on the validation results, obtained recommendation that the instrument used with minor revisions. This review is done based on the comments and suggestions given by the supervisor.

3.5 Main Product Revision

At this stage, revised the reference module (draft 1) into the module (draft 2) and all the instruments that have been made based on advice from experts. Revisions have been conducted by researchers to repair modules, namely (1) the addition of questions to think creatively and issues Olympics; (2) the improvement of grammar especially preposition adjusted language; and (3) development of charts and Venn diagrams relations. After the module revised and declared valid, the module used in a practical test.

3.6 Main Field Testing

At this stage conducted testing limited to 3 teachers, nine learners, and two mathematic readers to determine the practicality of the module. Three teachers consisted of SD (G-1), SMP (G-2), and SMA (G-3). Nine students consist of 3 SD (PD-1, PD-2 and PD-3), 3 SMP (PD-4, PD-5, PD-6), and 3 SMA (PD-7, PD-8 and PD-9). Two mathematic readers (M-1 and M-2).

Based on the results of teachers' questionnaire responses, obtained average yield response of teachers = $R_g = 4.53$ (maximum score 5) and is included in the excellent category. Results of the teacher's response to the reference module shown in Table 4 below.

Table4.The teacher's response to the Module

Response	Validator Value		
	I	II	III
Teacher's Response	4.41	4.56	4.63
Criteria	Very Good	Very Good	Very Good
R_g	4.53		
Criteria R_g	Very Good		

Based on the questionnaire responses of students, obtained average yield response of students = $R_{pd} = 3.13$ (maximum score 5) and including in right category. Results students response to the reference module shown in Table 5.

Table 5.Response of Students

Students	Response	Criteria	Percentage Response	Average
PD-1	3.69	Very Good	92%	Rpd= 3,13 (Good) Percentage Response = 78%
PD-2	2.80	Good	70%	
PD-3	2.80	Good	70%	
PD-4	3.44	Very Good	86%	
PD-5	3.36	Good	84%	
PD-6	2.82	Good	71%	
PD-7	3.09	Good	77%	
PD-8	3.00	Good	75%	
PD-9	3.16	Good	79%	

The third teacher gives suggestions: (1) language and writing system used in reference modules adapted to language; (2) the modules can be equipped with teaching VCD; (3) problems in the modules should be of a level is easy, rather easy, and challenging; (4) the language used in the module fixed to be simpler so easily understood by students; and (5) can be added high school subject so it used as a companion book high school students.

Ninth students advice that (1) exercises should also be added the answer key; (2) module is communicated to a wider student; (3) on the material triangle added about trigonometry subjects and speciality corners of the table; and(4) the words of motivation can be added.

Both mathematic readers advice that(1) it would be better if the module is separated from elementary schools, junior high schools and high school so that elementary school students are not confused, and(2) a mathematics problem more varied so that children grow accustomed to a lot of practice and creative thinking.

The average yield total score indicator mathematical creative thinking skills on the ninth students before and after using the OQALE based reference module for school geometry subject show an increase. Calculation test value gain of nine students presented in Table 6.

Table 6.Test Gain Mathematic Creative Thinking Skills Before and After Using Modules

Interviewees	The test result gain	Criteria
PD-1	0.76	High
PD-2	0.77	High
PD-3	0.72	High
PD-4	0.71	High
PD-5	0.53	Medium
PD-6	0.75	High
PD-7	0.77	High
PD-8	0.73	High
PD-9	0.50	Medium

4. Discussion

The research showed that through the stages Borg and Gall [2] obtained an OQALE based reference module for school geometry subject are valid, practical, and capable of improving the skills of creative thinking mathematically. Mathematical creative thinking skills improvement is due to the OQALE approach (Sukestiyarno, 2013) and the questions contained in the OQALE based reference module. The OQALE approach used in the module, in addition to constructing the way students learn from observing, questioning, analysing, associating, and expressing, also able to encourage students to

improve mathematical skills of creative thinking. The questions contained in the reference module is also problem-solving questions and problems of creative thinking mathematically arranged to start from easy to difficult level. Problems solving this problem proved to increase mathematical creative thinking skills students. That is according with what stated Siswono [1] which mentions that the forms of matter and matter that can foster creative thinking are a form of mathematical problem solving, filing problems or a combination of both.

Increased creative thinking mathematically through the OQALE approach and problem solving is consistent with what raised Rothenberg [13] and the results Mustakim (2015). Rothenberg [13] argues that scientific discoveries demonstrate the significant role to enhance creative thinking in science by prioritising the investigation. Meanwhile, the research results Mustakim states that learning scientific approach to solving the problem with organised can improve the mathematical skills of creative thinking and learning outcomes of students [9].

Increased mathematical creative thinking skills students can be observed through the activities students when working on covering observations aspects of fluency, flexibility, originality, and elaboration [8].

5. Conclusion

To obtain a reference module that can be used independently and can enhance the creative thinking mathematically crucial stages learning which can bring students improve mathematical skills of creative thinking. The steps employed in this reference module is OQALE stages. OQALE stages are proven to bring students to observing, questioning, analysing, associating, and expressing and able to enhance creative thinking skills, mathematical students.

Based on the results of research and discussion, It concluded the OQALE based reference module for school geometry subject is valid. The average validity module and included in the category of very valid and OQALE based reference module for school geometry issue practical with a mean response of teachers, including in the excellent category and the average response of students included in both categories with a response percentage students.

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