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by Meilantifa .

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BOOK OF ABSTRACTS

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Keynote Speaker:
Prof. Dr. Ocky Karna Radjasa, M.Sc.
(Director of Research and Community Services Kemenristekdikti)

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2 Prof. Dr. Julio Cabral Teehankee (Dean of College of Liberal Arts, De La Salle University, Philippines);
3 Ithiqah Nur Alami, S.IP, Ph.D. (National University of Singapore, Singapore);
4 Prof. Dr. Ismanto Hadi Santoso, MS. (Lecturer in Universitas Wijaya Kusuma Surabaya, Indonesia);
5 Evangelos Angelou Afendras, Ph.D (A former lecturer of Indian Institute of Management)
6 Dr. Pranav Kumar (Consultant, Edu Train International Bahrain)
7 Dr. Ir. Hary Sastrya Wanto, MS. (Lecturer in Universitas Wijaya Kusuma Surabaya, Indonesia);
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Development of Student Worksheet on Flat Geometry Learning Based on Rigorous Mathematical Thinking At Universitas Wijaya Kusuma Surabaya

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Abstract. This study aims to develop student worksheet based on Rigorous Mathematical Thinking (RMT) to know the understanding of the concept of flat geometry in the students of Mathematics Education Study Program at Universitas Wijaya Kusuma Surabaya. Rigorous Mathematical Thinking (RMT) is a learning approach to mediate students in using and adapting to their cognitive function to build understanding and understanding of concepts. The results of this study are the value of the test results of learning and student responses to knowledge. After implemented on the student then got the result according to an indicator of RMT that is four students there is at a high level, three students are at average level, two students in low concentration. The response of most students to RMT-based learning is positive.

Development of Student Worksheet on Flat Geometry Learning Based on Rigorous Mathematical Thinking At Universitas Wijaya Kusuma Surabaya

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***Abstract*— This study aims to implement the use of worksheet (worksheet) based on Rigorous Mathematical Thinking (RMT) to know the understanding of the concept of flat geometry in the students of Mathematics Education Study Program at Wijaya Kusuma University Surabaya. Rigorous Mathematical Thinking (RMT) is a learning approach to mediate students in using and adapting to their cognitive function to build understanding and understanding of concepts. The results of this study are the value of the test results of learning and student responses to learning. After implemented on the student then got the result according to an indicator of RMT that is four student there is at a high level, three students are at average level, two student is in low level. The response of most students to RMT-based learning is positive.**

Keywords—worksheet; Rigorous Mathematical Thinking (RMT); geometry

I. INTRODUCTION (*HEADING 1*)

Student worksheets are still widely used in mathematics learning in primary, secondary, and university schools. The use of this worksheet is to know the representation of students in understanding mathematical concepts [1]. The mathematical concept studied in this study is the flat geometry that has studied in secondary schools. Most students still have not been able to prove the theorems by definition and axioms. They need help from friends and lecturers to be able to start the proof. Meanwhile, related to the problem solving, the students also still read the example about the step of proof and image. The learning process involving Rigorous Mathematical Thinking (RMT) interventions emphasizes mathematical psychological tools. RMT is a revolution in the geometry learning process developed by James T. Kinard in Chicago. Kinard [2] defines RMT as follows. First, a combination and utilization of mental operations to acquire knowledge of patterns and relationships. Second, to adopt the habit of acquiring equipment and schemes to elaborate further on knowledge to bring about understanding and understanding. Third, to transform and generalize concepts and understandings into logical ideas. Fourth, to plan the use of ideas to facilitate problem-solving and the decline of new concepts in different contexts and outcomes of the human activity. This study aims to implement the use of RMT based worksheets to find out the understanding of the concept of flat geometry in the students. Kinard & Kozulin (2008: 122) stresses that teaching involving RMT intervention is a process that alters the content of geometry through rigorous bonding. The formation of RMT, as well as the development of geometry and science concepts, are developed and achieved through a strong bond between patterns and relationships.

Gambar 2.1 : Ikatan Rigorous untuk RMT

Kinard & Kozulin [2] says that for rigorous mathematical thinking three levels of cognitive function are needed, namely general cognitive function for qualitative thinking, cognitive function for quantitative thinking with rigor and cognitive function for generalization, abstract relational logical thinking in geometrical culture. Of the three levels of cognitive function described above, the researchers formulated an indicator to classify student RMT levels into four levels, namely non-RMT levels, low, medium and high.

Cognitive function level is the general cognitive function for qualitative thinking. The cognitive function consists of labeling-visualization is to provide a name based on its critical attributes while shaping the image in mind or generating an internalized construction of an object with its surname presents. Second, benchmarking is looking for similarities and differences between two or more objects, events or situations. Third, systematic search to collect and furnish information that is noticed in a meaningful, organized, and full-fledged way to manage and provide information. Fourth, the use of more than

one source of information is to work metallically with two or more concepts at the same time, like color, size, and shape, or test the situation from multiple points of view. Fifth, code-encoding which is to put meaning into the code (symbol/sign) and take the purpose of the system.

Levels of cognitive function for quantitative thinking with meticulousness and cognitive tasks for generalization consist of preservation of determination, i.e., Cidentify and explain what remains the same concerning regarding attributes, concepts or relationships, while some others change. Second, space measurements and spatial relationships Using an internal and external reference system as an integrated guide or guide to organize, analyze, help articulate, and measure differences, spatial representations and spatial relationships based on the overall to partial ties. Third, measurement of time and temporal relationships that set the reference to categorize measure, and sort time and temporal relationships based on the overall link to a part. Fourth, analyzes-integration is to decompose the whole or decompose quantity into its critical attributes or amount of supplies; build the whole by combining its elements, its essential characteristics, or compiling its numbers by connecting the other quantities. Fifth, generalization is to observe and describe the nature or behavior of an object or group of objects without referring to its particular details or critical attributes. Sixth, accuracy is struggling to focus and be right.

Cognitive function level for generalizing, abstract relational logical thinking in geometry culture. First, activation of prior geometrical knowledge is to mobilize geometry knowledge obtained previously by searching through experience, to make relationships and coordination aspects of things that consider and issues of past experiences. Second, provision and articulation of logical-mathematical events. Provide supporting details, clues, and reasonable evidence to prove the validity of statements, hypotheses or conjectures that generate allegations, questions, answer answers, and communicate explanations while complying with geometry rules and ensuring logical consistency. Third, Defining the problem is seeing by analyzing and understanding the relationship to know what to do mathematically. Fourth, thinking hypothetically-inferencing that is forming geometric propositions or hypotheses and looking for mathematical, logical evidence to support propositions/hypotheses or deny them. Fifth, develop valid generalizations and proof based on some geometric events.

II. METHODS

This research is qualitative research with a type of case study. Research location in Surabaya Wijaya Kusuma University Mathematics Education Study Program. The research conducted from September 2017 to January 2018. The students as the subjects of the study consisted of 9 students. The design of the study is to carry out the preliminary survey, then done a designing model of flat geometry learning device for students of mathematics teacher candidate in the form of student worksheet. After that, the research team conducted the test and the implementation of the RMT-based student worksheet to the students. In this study, the data obtained included primary data and secondary data. Primary data derive from the direct data source that is the values of students who program Geometry Field course in the last three years. Whereas secondary data in the form of student learning outcomes data after working on a worksheet containing flat geometry questions. Data collection was conducted by the test method in the way of learning result test and questionnaire method in the form of a questionnaire to know the student response during learning. Data analysis of learning outcomes begins with giving the next test score, and students are said to be complete if the value is more than or equal to Minimum Criterion completeness (KKM). After that, adjustments made to the RMT indicators that had set as follows.

TABLE I. INDICATOR OF RMT

Indicator	Level RMT
Students reach all three levels of cognitive function	High
Students reach two levels of cognitive function	Medium
Students reach one level of cognitive function	Low
Students have not achieved all three levels of cognitive function	Not RMT

While the analysis of student response data based on the results of the questionnaire with the following calculations.

$85\% \leq R\_s$ = Very Positive

$70\% \leq R\_s < 85\%$ = Positive

$50\% \leq R\_s < 70\%$ = Less Positive

$R\_s < 50\%$ = not Positive

III. RESULT AND DISCUSSION

The result of the research is the result of the test result which had compared with minimum criterion determined and the result of a questionnaire of student response after the RMT (Rigorous Mathematical Thinking) based flat geometry.

TABLE II. TEST SCORES AND LEVEL RMT

Students Name Code	Score	KKM	Level RMT
LS	70	complete	Medium
YD	85	complete	High
MJ	70	complete	Medium
EP	60	complete	Low
MJ	90	complete	High
AA	89	complete	High
ES	85	complete	High
RFA	60	complete	Low
FN	77	complete	Medium

From the results of the test results of learning outcomes obtained by students about understanding the concept of flat geometry shows that most students have been able to explain and solve questions about triangular congruence and congruence. Overall students complete in learning because their value is above the minimum criterion that has been determined by completeness. Whereas compared to the RMT indicator four students who achieve the three levels of cognitive function, three students only reach two levels, and two students still reach one level.

Students who only reach one level are only able to connect the initial knowledge about the flat building that they learn with the subject matter in flat geometry material such as triangles and circles. Students who reach two levels can explain in their own words about some definitions and theorems that may have been learned before. In this case, he is able to activate memory about the characteristics of a flat build. At the next level, he is able to construct hypotheses and construct logical sentences based on definitions and axioms that are remembered to prove an existing theorem. Students with high RMT levels are very understanding of what is conveyed and can receive all new forms of flat building even though it is not the same as the previous learning experience. They can hypothesize what to look for from a geometrical problem, such as proving congruent opposite angles, proving the similarity theorem, by determining the axioms and images that can be used to prove it. They compile proof steps in a coherent and logical way with proof of definition and axiom of each step that is compiled. In addition, they can also describe these steps to support written evidence.

TABLE III. STUDENT RESPONSE

Students Name Code	Response
LS	Positive
YD	Positive
MJ	Positive
EP	Less Positive
MJ	Very Positif
AA	Positive
ES	Positive
RFA	Less Positive
FN	Positive

All students have a positive response to learning using RMT. They felt that learning using LKS helped them explore past experiences or information about the geometry they had learned in high school. They are stimulated to think critically and creatively in finding and linking definitions and axioms suitable for proof.

IV. Conclusion

The results of this study in the form of learning outcomes test scores and student responses to learning. After being implemented in students, the results are in accordance with the RMT indicator, that is 4 students at a high level, 3 students at a medium level, 2 students at a low level. The response of most students to RMT-based learning is positive.

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