The Development of Learning Tool Models on Triangle using Problem Solving Based of Rigorous Mathematical Thinking in Wijaya Kusuma Surabaya University

IOP Conf. Series: Journal of Physics: Conf. Series **1028** (2018) 012141 doi:10.1088/1742-6596/1028/1/012141

The Development of Learning Tool Models on Triangle using Problem Solving Based of Rigorous Mathematical Thinking in Wijaya Kusuma Surabaya University

Meilantifa[1], Herfa Maulina DS[1], Mega Teguh Budiarto[2] and Janet Trineke M[2]

[1]Wijaya Kusuma Surabaya University
[2]Surabaya State University

meilantifa@gmail.com

Abstract: Geometry learning given to Mathematics education program, Faculty of Language and Science, Wijaya Kusuma SurabayaUniversity use various strategy and learning models even acquired maximum result. Students still have difficulties this to prove theorems, therefore concepts understanding is needed about triangle. One of the alternatives that can build up geometry concepts in students mains is by carrying out an approach of Rigorous Mathematical Thinking (RMT). The goals of this research are to describe processes and results of the development learning tools models of triangle using problem solving based on Rigorous Mathematical Thinking (RMT). This Research is a developmental one which carried out for the students of Mathematics education program, Faculty of Language and Science University of Wijaya Kusuma Surabaya academic year 2017-2018. The research object is learning triangle using problem solving approach. Two subjects are subject for validation and subject for limited try out. The learning instruments consist of validation sheets, observation of students activity sheets, students response sheets and test. The technique of data collection uses observation method, test, and questionnaire. Research yields teaching handbook, syllabus and student activity sheets.

1. Introduction

Geometry is the study of patterns and relationships [1]. The study is facilitated by tools which are obtained culturally and scheme developed and forced the dynamics of mathematical thinking. Mathematical thinking synthesizes and utilizes cognitive processes that increase higher abstraction level, therefore it must be rigorous in character [2]. About rigorous in thinking, there are three elements of rigor described by the originator of RMT, which are:

1) Sharpness of focus and perception;
2) Clarity and comprehensiveness in definitions, conceptualizations and delineation of critical attributes);
3) Precision and accuracy.

Learning geometry that has been done in the Mathematics Education Program, Faculty of Languages and Science, Wijaya Kusuma SurabayaUniversity is still the same in recent years. References used are textbooks published by the Malang State University and the Surabaya State University. They use a variety of strategies and learning models so that students are more motivated to

learn, but the results are not significant. Students still find difficulties to prove the theorems, so that they need more help to guide on the definition and relate theorems to find the proof.

Based on the results of observations that have been done, the data obtained ability of students Wijaya Kusuma Surabaya University as in Table 1.

Table 1 Percentage of last score students' in Geometry course in the last 3 years.

Students	**Odd 13/14**	**Odd 14/15**	**Odd 15/16**
High Ability	10%	16%	15%
Moderate Ability	80%	55%	70%
Low Ability	10%	39%	15%

Table 1 shows that students with moderate skills still dominate in the learning with the largest percentage in each generation. While high and low ability students are also not adrift far difference percentage. Based on the results of interviews with students and learning experiences, the findings are as follows: (1) Student were late to follow explanations given by lecturers, (2) students could not relate the relationship between definitions and axioms in proof and solve problem solving, (3)) students did not try to do other problems except given by the lecturer as a reinforcement, and (4) students lack to understand the problem in the form of a word problem.

Basically symbols in geometry are not easy to understand by students who previously lack understanding in geometry. Although the symbols have been studied previously in elementary and secondary school, most mathematics students still get difficulty to understand when faced with a problem solving. If the student can understand the symbol then this will make him easier in solving the geometry problem. Solving geometry problem is not easy for the students especially for student who has bad geometric ability. Therefore, the mediator is needed to mediate in the process of forming the concept of geometry that makes the students be able to utilize the psychological tools as much as possible so that they form a good understanding of the geometry concept and when dealing with geometry problems then the students will not have difficulty in determining the solutions.

Under such conditions, it needs innovation for learning to improve students' understanding of geometry. One of them is by making learning tools more effective. The learning process involving Rigorous Mathematical Thinking (RMT) interventions emphasizes on mathematical psychological tools. RMT is a revolution in the geometry learning process developed by James T. Kinard in Chicago. The idea of RMT was revealed by Kinard in an unpublished manuscript around the 2000s. Kinard (2001) defines RMT as a combination and utilization of mental operations to: (1) acquire knowledge of patterns and relationships; (2) adopt the habit of acquiring equipment and schemes to elaborate further on knowledge to bring about understanding; (3) transform, generalize concepts and understand into logical ideas; (4) plan the use of ideas to facilitate problem solving and the decline of new concepts in different contexts and outcomes of human activity. From the findings and definitions of RMT, it is necessary to develop the implementation plan of learning and handout activity by paying attention the existing cognitive function. Cognitive function is a mental process that has a special meaning that conveys for particular act of thinking that is necessary to elaborate the abstraction and generalization of geometry directly.

The RMT application focuses on mediating students in building strong cognitive processes together with building geometric concepts using three phases with six step processes. These processes do not proceed linearly. However, each phase and step is important for student to involve in conceptual understanding of geometry. RMT involves cognitive, affective and conceptual dimensions. In this sense, the RMT process is an infusion that energizes and expands the learning of geometric concepts and problem-solving [2].

Table 1, shows that the majority of students who get high score are in moderate and low ability. It is not enough if the learning is done only oriented to cognitive function and psychological equipment. There needs to be an improvement in problem-solving training, since basically problem solving is the basis for learning mathematics.

Thinking about solving problems and producing something new are a complex and closely related activity to each other. A problem generally can not be solved without thinking, and many problems require new solutions for people or groups. Instead, producing something (things, ideas) that are new to someone, creating something include problem solving. This means that fact information and concepts are not important. As we have seen, the mastery of information is necessary to find concepts; they should be remembered and considered in problem solving and creative action. Similarly, intellectual development is very important in problem solving (Slameto 1990: 139)

This problem solving method emphasizes on continuous discovery and problem solving. "The advantages of this method encourage students to think scientifically, practically, intuitively and work on their own initiative, foster an objective, honest and open attitude. While the weakness takes a long time, not all the subject matter contains the problem, requires a regular planning and mature. It is ineffective if there are some students who are passive it. Will be interesting if students can use psychological equipment and problem solving well.

2. Method

This research belongs to a developmental research. Researchers undertook research to design and to develop geometry learning tools with problem solving based of RMT namely Course Teaching Unit (CTU) and Textbook Geometry.

Tools that have been compiled are validated to 2 expert / tool experts and geometry. Tool experts and geometry come from two different universities. After validation, the device was tested to four students of mathematics education program. Each student comes from two different universities and are in the 5th semester.

A good quality learning tool is a learning tool that meets the valid, practical, and effective nature.

a. Valid
   Learning tools are valid if (1) the validator's assessment of the learning tools of the Lesson Plan and Worksheet get the minimum value of "3" for each aspect of the assessment whereas THB in the minimum category is "valid enough" for content validation and the minimum category "understandable" for the discussion validation and writing test questions and (2) learning result test fulfilling the criteria of validity of the item is at least enough, the reliability of the test is minimal and the sensitivity of the item is at least 0.30.
b. Practical
   The learning tool is said to be practical if (1) the tool can be used by the teacher shown by the observation result of teacher ability in managing the learning, that is the assessment of every aspect in each meeting get minimum score "3" for each aspect of assessment and (2) that students can follow the learning activities in accordance with the allocation of time set in the Lesson Plan.
c. Effective
   Learning tools are said to be effective if the students' positive responses to the assessment of learning tools is at least 75% of all aspects of the assessment.

3. Results and Discussion

In fact, the syllabus, CTU, and geometry teaching materials used in the last three years indicate that lecturers still use conventional teaching methods and give assignments so that students tend to be less understanding with the concept of geometry, especially to prove theorems that involve many axioms and definitions and students are not active in searching for other references that result in lower students' final grades after taking the course. References used by lecturers are also limited and there are no exercise questions and enrichment to deepen the insights and skills of students about geometry, especially in proof and reasoning. The syllabus and CTU used also was not significant revisions from year to year so it could not accommodate the needs of students who want to be actively involved in

learning and get good grades for the course Geometry, considering the course is a prerequisite for the another course.

The geometry learning tools developed include CTU, and geometry Textbook. The tools have been validationed and tested legibility to students of mathematics education program. According to the test of learning device quality that has been done by the expert of learning tool and geometry, it is found that learning tool based on RMT (in the form of geometry textbook and test of learning result) is said to be good quality. This can be seen from the fulfillment of the properties as follows.

1) Valid
   Learning tools are said to be valid because (1) the validator's assessment of instructional means that the textbooks get the value of "4" for each aspect of the assessment, the category "valid enough" for content validation and the "understandable" category for the validation of the discussion and the writing of the questions and (2) test result of study fulfill the criterion of validity of item enough, enough test reliability and sensitivity of item 0.50.
2) Practical
   Learning devices are said to be practical because (1) validated devices can be used by lecturers shown by the assessment results of each aspect of each meeting getting a "3" score for each aspect of the assessment and (2) Lesson plan using a RMT-based learning strategy is easy to implement.
3) Effective
   Learning devices are said to be effective because students' positive responses to learning tools reach 85% on every aspect of the assessment of the device.

As for the results of legibility test of mathematics education program students, most stated that the learning device already meets the appropriate competency standards and tend to be easily understood in the presentation so that the learning tool is feasible to be used in learning.

4. Conclusion

Learning tools developed include CTU and Geometry Books have met the valid, practical and effective criteria, so that the tool is suitable to be used in learning at universities. The feasibility of legibility also meets the criteria as well.

Acknowledgments

The authors wish to thank the people who helped a lot in the preparation of textbooks for research development of learning tools of this geometry those are Marulam Situmorang andMochammad Amirudin.

References

[1] Kinard J T and Kozulin A 1998 *Psychological Tools : A Sociocultural Approach to education* (London : Harvard University Press)
[2] Kinard J T and Kozulin A 2009 *Creating Rigorous Mathemaical Thinking: A Dynamic that Drives Mathematical and Science Concptual Development. Retrieved on October 21, 2009* from www.umanitoba.ca/unevoc/conference/ papers/ kinard .pdf.
[3] Arikunto S 2006 *Proses Penelitian, Suatu Pendekatan Praktik* (Jakarta : Rineke Cipta).
[4] Bohm D 1968 *On Creativity Leonardo Vol 1* (Pergamon Press. Printed in Great Britain).
[5] Crawford B, de la Barra and Claudio Le´on 2008 Does eXtreme Programming supportCollaborative Creativity? *Proceedings of the International MultiConference of Engineers and Computer Scientists* I 19-21.
[6] Csikszentmihalyi M 1997 *Creativity* (New York : Harper Perennial).
[7] Direktorat Jenderal Peningkatan Mutu Pendidik dan Tenaga Kependidikan, Depdiknas 2008 *Kreativitas* (Jakarta : Depdiknas)
[8] Falik L H 2009 *Changing Children's Behavior : Focusing on the "E" in Mediated Learning Experience, Retrieved on Desember 4*, from http://www.icelp.org.
[9] Fitriyani H 2010 *The Student Thinking Process of Junior High School in solving the Geometri Problem Seen from the Rigorous Mathematical Thinking (RMT) Paradigm*. Makalah

disajikan pada Seminar Nasional Geometri dan Pendidikan Geometri FKIP Universitas Muhammadiyah Malang Malang
[10] Kinard J T and Kozulin A 2008. *Rigorous Mathematical Thinking : Conceptual Formation in the Mathematics Classroom* (New York : Cambridge University Press).
[11] Kinard J T 2010 *Rigorous Mathematical Thinking, Retrieved on January 23, 2010 from http://rmtchicago.com.*
[12] Kozulin A, Gindis B, Ageyev V S and Miller S M 2003 Vygotsky's Educational Theory in Cultural Context (New York: Cambrige University Press).
[13] Lumsdaine E 2007. Creative Problem Solving in Capstone Desig.pdf http://www.innovationtoday.biz/pubs /2007ASEE CPS_Design.pdf retrived on 03 Februari 2011.
[14] Maleong L J 2007 *Metodologi Penelitian Kualitatif* (Bandung : Remaja Rosdakarya).
[15] Napitupulu E 2009 *Kreativitas Pembelajaran Geometri Terus Berkembang* (Jakarta : Kompas).
[16] Nur M 2004 *Teori-teori Perkembangan Kognitif* (Surabaya: UNESA).
[17] Palaniappan A K 2006 *Academic Achievement of Groups Formed Based on Creativity and Intelligence. Faculty of Education*, University of Malaya.
[18] Polya G 1973 *How To Solve It; A new Aspect of Mathematical Method* (New Jersey: Princenton University Press.)
[19] Scoenfeld A 1985 *Mathematical Problem Solving* (Florida : Academic Press).
[20] Silver E A 1997 *Fostering Creativity through Instruction Rich in Mathematical Problem Solving and Thinking in Problem Posing* ZDM Volume 29 No 3
[21] Siswono T Y E 2007 *Penjenjangan Kemampuan Berpikir Kreatif Dan Identifikasi Tahap Berpikir Kreatif Siswa Dalam Memecahkan Dan Mengajukan Masalah Geometri*. Disertasi, Universitas Negeri Surabaya.
[22] Soedjadi 2000 *Kiat Pendidikan Geometri di Indonesia* (Jakarta : Depdiknas).
[23] Sugiyono 2009 *Statistika untuk penelitian* (Bandung : Alfabeta).
[24] Taggar S 2002 *Individual Creativity And Group Ability To Uti'ii.Ze Individual Creative Resources: A Multilevel Model Academy of Management* Journal 45 No. 2 315-330.
[25] Yamamoto K and Davis 1964 *Creative Thingking and Achievment Test item Responses of Elementary School Pupils : A Premilinary Investigation* (Kent State University Ohio).
[26] Zanzali A 2006 *Evaluating the Levels of Problem Solving Abilities in Mathematics Fakulti Pendidikan* Universiti Teknologi Malaysia.