Development of Metacognitive Learning Model Device oriented by HOTS to Improve Students Mathematical Literation

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Abstract. This study aims to develop metacognitive learning models device oriented by HOTS to improve student mathematical literacy which is valid, practical and effective. The learning devices developed are (1) Lesson Plan (RPP), (2) Student Activity Sheet (LAS). This study was research and development that used Plomp model which include: (1) Initial investigation phase, (2) Design phase, (3) Realization phase, (4) Test, revision and evaluation phase, (5) Implementation phase. The results showed that the learning device (RPP and LAS) had been fulfill of aspect validity, practically, and effectively.

Keywords: metacognitive model, HOTS, Mathematics Literacy

1. Introduction

Mathematics is one of the most useful sciences in human life. Mathematics is not only about enumeration, counting, and measuring, but also used to solve the problem correctly (problem solving) and how to be creative in seeking the right answer with various ways (open-ended problem). Mathematics becomes important because every human activity is inseparable from mathematics. Someone who understands and have sense about the use of mathematics will more easily interpret and critically analyze the situation in daily basis [1].

A person’s capability to formulate, apply, and interpret mathematics in various context, including the ability to do mathematical reasoning and use concepts, procedures, and facts to illustrate, explain, or predict phenomenon, is referred as mathematical literacy ability [2]. Education as the medium in facing challenges in the globalization era is expected to be able to equip students with mathematics literacy skill or broadly, can apply their knowledge in their daily life.

The achievement of mathematical literacy is seen from Indonesia’s participation in several international comparative studies, such as trends in International Mathematics and Science Study (TIMMS) and Programme for International Student Assessment (PISA). The result of TIMSS study aims to know the development of mathematics and natural science of students in the aged of 13 years old have not shown a satisfactory achievement. The result of PISA from the past few years, specifically in 2015 with the score of 386 in mathematics has increased, compared to 2012 with the
score of 375. However, compared to overall average of 490, the achievement level is still below the average [3]. The low of literacy is indicated caused by instrument that used to measure the higher order thinking skills (HOTS) have not been properly mastered by the students.

21st century learning emphasized on Higher Order Thinking Skills (HOTS), but so far, learning still dominantly convey knowledge only and has not triggered students to think analytically, evaluate, and create [4]. Students should be directed to achieve high-level competence through various innovative learning activities, for example, through metacognitive learning [5]. Metacognitive learning could make students realize the importance of mastering the mathematical ability, practice self-learning, and able to realize their weaknesses and strengths, so they can control the knowledge [6].

Metacognitive ability is a cognitive ability that is deemed relevant to high-level ability, because metacognitive is a thinking ability that requires knowledge of one’s knowledge and knowledge of others, so that is expected to improve the mathematical literacy skill. Based on the explanation above, the researcher considers the development of metacognitive oriented learning HOTS Model as the effort to improve student’s mathematical literacy.

2. Literature

2.1. Metacognitive Model
Wells argues metacognition as “the cognitive processes, strategies, and knowledge that are involved in the regulation and appraisal of thinking itself” [7]. The syntax of the metacognitive learning model is as follows. (1) Preliminary, at this stage, students explore the initial knowledge related to the material to be discussed. (2) Development of cognitive abilities, at this stage, students are given the opportunity to solve cognitive type problems. (3) Development of metacognitive abilities, before the development of metacognitive type abilities is developed, initially; students are first given a metacognitive type math problem, and then proceed with the next phase. (a) Planning, the teacher guides students in planning and implementing the completion procedure, the cognitive strategy used, and the relevant initial knowledge in solving the problem given. (b) Monitoring, the teacher guides students in monitoring completion procedures, relevant initial knowledge and cognitive strategies used. (c) Reflection, the teacher guides students to reflect on the process of understanding concepts that have been done in activities to solve metacognitive mathematical problems. This is done by comparing the results obtained by students to the given statements so that in this case there will be a process of control and reflection on cognitive activities that have been carried out. (4) Closing, at this stage, students are guided in making conclusions from the learning that has been done [8].

Based on several opinions stated above, it can be concluded that the metacognitive Learning Model is a learning model designed to increase awareness about the thinking process in learning so that when this awareness is realized, then someone can guard his mind by designing, monitoring and evaluating what he learns.

2.2. High Order Thinking Skills (HOTS)
Thomas & Thorne declared that higher order thinking is thinking at a higher level than simply remembering facts or retelling something heard to others [9]. HOTS are a thinking skill that not only requires the ability to remember, but also other higher capabilities include the ability to analyze, evaluate, and create [10]. Higher order thinking occurs when students gain new knowledge and stores it in memory, and then this knowledge correlates with prior knowledge to achieve a particular goal [11].

The characteristics of HOTS are: (a) non-algorithmic, meaning that action steps cannot be fully determined at the beginning; (b) complex, meaning that the steps cannot be seen or guessed directly from a particular point of view; (c) produce many solutions; (d) involve dissent or interpretation; (e) involves the application of multiple criteria; (e) involves uncertainty; (f) demanding independence in the thinking process; (g) involves impressive meanings; (h) requires hard work (effortful) [12]. Based on some opinions above, it can be concluded that Higher Order Thinking Skills (HOTS) is a high-level
way of thinking by analyzing, synthesizing and evaluating information in order to it can interpret and make decisions on certain conditions and create something new.

2.3. Mathematical literacy
Mathematical literacy is ability to formulate, employ, and interpret mathematics in variety of contexts. It includes using mathematical reasoning and mathematical concepts, procedures, facts, and tools to describe, explain and predict phenomena [13]. It assists individuals to recognize the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged, and reflective citizens [14].

The connection between Mathematical literacy level PISA, Bloom Taxonomy, and HOTS [15], [16] are:

| Level | PISA | Bloom Taxonomy | Competence aspect |
|-------|------|----------------|-------------------|
| Low Order Thinking | | | |
| Level 1 | Students can use their knowledge to solve routine problems and finish general problems. | C1 | The ability to recall information/knowledge that saved in memory |
| Level 2 | Students can interpret problems and solve it with formula | C2 | The ability to understand instructions and affirm the definition/meaning of ideas or concept that have been taught either in oral, written, or graphic/diagram |
| Level 3 | Students can use procedures well in solving the problems and can choose the strategy to solve to problem. | C3 | The ability to do something and applied the concept in certain conditions. |

| High Order Thinking | | | |
| Level 4 | Students can work effectively with models and can choose and integrate different representation, and connect them with real world | C4 | The ability to separate concepts into several components, and connect it others to obtain understanding of the concept completely. |
| Level 5 | Students can work with models in complex situations and able to solve complex problems. | C5 | The ability to determine the level of something based on norm, criteria, or certain standard. |
| Level 6 | Students can use their reasoning to solve mathematics problem, able to generalize, formulate, and communicate their result. | C6 | The ability to combine elements into a whole new and coherent form, or create something original |

Reflection cluster present unstructured situation and ask their students to identify and find mathematics idea behind the problem, can use the mathematical thinking deeply and use it to solve.
3. Method

3.1. Research Approach
This research is a development research. The subjects of this research are Students from class VIIA MTs (Islamic Junior High School) Perama Tutallu Foundation Polewali Mandar. The development model used in this research refers to Plomp model. There are 5 steps that must be passed in developing a learning model [17]:

![Diagram of research approach]

3.2. Scoring Instruments and Guidelines
To get a mathematics learning device with a valid, practical and effective metacognitive model, the data were obtained from the research instruments, that is, Validation Format, Lesson Plan, LAS, Learning Outcomes Test, Observation Sheet, and Student Response Questionnaire.

3.3. Data Analysis
The collected data will be processed descriptively. Learning device in this research must reach a minimum of valid, practical, and effective categories. To reach the valid category, the validation sheet score should reach at least $2,5 \leq Sr < 3,5$. 

4. Result and Discussion

4.1. Analysis of Results of Stages of Development of Learning Devices

The results of the development of learning devices are described as follows:

4.1.1. Initial Investigation Phase
In this phase, the analysis of the learning situation showed the quality of learning is still low, where the activities and abilities of students in Mathematics Literacy are still low and the unavailability of learning device that provide opportunities for students to realize their metacognition activities, therefore, they are expected to be able to improve their mathematic literacy skills through the introduction of HOTS questions in learning activities.

In this analysis, the solution offered is conducted a study of the theory that support and it will be tried to develop metacognitive learning HOTS oriented. The implementation needs to be developed relevant learning. Learning device developed in this study is a student activity sheet, and lesson plan on Number Theory.

4.1.2. Design Phase
In this phase, the activity begins with designing learning tools that will be developed to support the application of metacognitive learning HOTS-oriented. The results of this design are the form of an initial draft from the student activity sheet and lesson plan.

4.1.3. Realization Phase
In this phase, the solution that has been designed is realized to be able produce an initial prototype. The resulting prototype is still in the form of prototype 1 which including LAS and Lesson Plan which then need to be tested for validity, practicality, and effectiveness.

4.1.4. Test, Revision and Evaluation Phase
The first prototype was produced at the realization phase then tested for validity by 2 experts from Malang State University. Based on the results of the validation test on the learning device, then a small revision is made, therefore, it gets a learning device form of second prototype with valid learning device criteria which was developed. The instruments that will be used in the trial activities were valid. After the learning device was obtained in the form of second prototype, then field trial were conducted. Field trials were conducted to determine the practicality and effectiveness of the learning tools developed. At this phase, trials are conducted twice, namely cycle 1 and cycle 2, where at the end of the cycle 2 activities the aspects of practicality and effectiveness of the learning tools developed in this study were fulfilled. After the pilot activities, revisions were made as needed on second prototype, so that; it became the final prototype of the Metacognitive Learning HOTS-Oriented Model for MTs students Class VIIA MTs (Islamic Junior High School) Perama Tutallu Foundation in Polewali Mandar.

4.1.5. Implementation Phase
The learning device in the form of the final prototype will be submitted to the teacher concerned which is introduced and further developed in other teachers at MTs (Islamic Junior High School) Perama Tutallu Foundation in Polewali Mandar.

4.2. Validation Result
The following table is a summary of the validator’s results to the assessment of the learning tools:
Table 1. Description of the expert results to assessment of learning devices

| Devices            | Indicator                      | Assessment |
|--------------------|-------------------------------|------------|
| Lesson Plan        | Format                         | 4.00       |
|                    | Language                       | 3.75       |
|                    | Content/Activity Learning      | 3.60       |
|                    | Average                        | 3.78       |
| Student Activity   | Format                         | 3.91       |
| Sheet              | Language                       | 3.87       |
|                    | Illustration                   | 3.83       |
|                    | Content                        | 3.58       |
|                    | Average                        | 3.79       |

In the Lesson Plan validation sheet the experts suggest, i.e.; Learning Objectives in the aspect of understanding must reach the phase of distinguishing examples and non examples of comparison of two quantities. The use of language needs to be examined so that the sentence structure is clear; assessment needs to be attached. Furthermore, the LAS validation sheet is suggested, i.e.: Indicators need to be added, emphasis on questions that activate metacognitive abilities and insert examples of high-level thinking / HOTS questions.

4.3. Practically Results of the Device
Theoretically, the results of the expert’s assessment and practitioners in the field of mathematics education towards learning devices with metacognitive learning HOTS-oriented models stated that the devices which have been developed are suitable for use in the learning process. While empirically, based on observations of the learning device by the observer stated that the learning device was implemented well at the time of the trial. Based on the evaluation of observers and validators, it can be concluded that the learning device meets the practicality criteria.

4.4. Device Effectiveness Result
The effectiveness criteria for learning device includes: (1) completeness of learning outcomes, (2) student activities, (3) student responses, (4) student literacy abilities that are measured using HOTS questions. The criteria that must be met, so that a learning device is said to be effective is at least 3 of the 4 criteria are met, but indicator 1 must be met. From four indicators above, only 3 aspects were met in the trial, while the aspect that did not meet the effectiveness criteria was the ability of student literacy because there were still competencies to be developed which namely reflection competencies that demand high-level interpretation with contexts that were completely unexpected by students. This is relevant to the results of the 2015 TIMSS study recommending that Indonesian students still need to be developed further for high-level mathematical skills, one of the higher-order thinking is the ability to think creatively. Through mathematics learning, students are expected to be able to develop creative thinking skills and have a curious attitude towards mathematics [18].

5. Conclusion
The results shown that the learning device (RPP and LAS) was had been fulfill of aspect validity, practically, and effectively.

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