

Research Article

# Validity of the problem-based learning model based on metacognitive oriented to improve critical thinking skills

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## ABSTRACT

This study aims to develop a problem-based learning model based on metacognitive that is oriented towards improving students' critical thinking skills. This research is a Research & Development. The research procedure used for research and development by Borg & Gall. The development steps include: Research and Information Collection, Planning, Develop Preliminary of Product, validation by experts, Preliminary Testing, and Main Field Test. However, this research is limited to the step of validation by experts. The subjects of this research were 1 teacher and 2 lecturers. This research instrument are validation sheet for experts and a validation sheet for practitioners. The results of this research are (1) the design of a problem-based learning model based on metacognitive that is oriented towards improving critical thinking skills; (2) learning tools in the form of: Learning Implementation Plans and Student Worksheets in the topic "the three-dimensional (3D) shape with flat surface" of class VIII SMP even semester. The results of the expert and practitioner's validation analysis met the valid criteria. The model development design assessment score is 80%, Learning Implementation Plan score is 88%, and the Student Worksheet score is 88%. Overall, the product developed is suitable for use. Based on the assessment by experts, theoretically, product development can be used to improve students' critical thinking skills.

**Keywords:** problem-based learning; metacognitive; critical thinking skills; validity

## 1. INTRODUCTION

One of the hopes of an education is to develop students' skills. Based on Permendikbud (Regulation of the Minister of Education and Culture of the Republic of Indonesia) number 20 of 2016, there are several Graduate Competency Standards (SKL) that must be owned by junior high school graduates, one of which is the ability to think critically. That is, the ability to think critically is a graduation standard in junior high school. This is a challenge for teachers in the learning process, especially mathematics in junior high schools (SMP).

Meanwhile, the current curriculum emphasizes learning that is oriented towards critical thinking skills. This shows that critical thinking skills are things that need special attention in the learning process. Critical thinking skills are a person's skills in processing information. Not only believe in the information obtained, but also analyze the facts related to the information obtained. This opinion is supported by Paul (in Sihotang et al, 2012: 5) that critical thinking is a high intellectual skill to understand, apply, analyze, synthesize, or evaluate the information obtained. Or simply can be interpreted as a reasoning process that is critical to an information. So it can be said that critical thinking skills are part of higher-order thinking skills (Novtiar & Aripin, 2017: 120). Meanwhile, in the opinion of Abdullah (2013: 66) critical thinking is a process that aims to make sensible decisions, so that what is considered the best about a truth can be done correctly. Abdullah (2013: 66) also adds that a person is considered to have critical thinking if he can obtain knowledge carefully, does not easily accept opinions, but considers first using reasoning, so that the conclusions are reliable and can be accounted for. Meanwhile, critical thinking that is trained in mathematics learning is a reflective thinking skill that focuses on making decisions about what to believe and what to do (Ennis, 2011: 1).

Ennis (1985: 46) divides indicators of critical thinking skills into five groups, are as follows: (a) Elementary clarification, (b) Basic support, (c) Inference, (d) advanced clarification, (e) Strategies and tactics. Meanwhile, the basic elements of critical thinking skills in the opinion of Ennis in Gustiningsi (2015: 144) abbreviate it to the acronym FRISCO, namely: focus, reason, inference, situation, clarity, overview. So, the indicators of the critical thinking skills in mathematics used in the study are as follows:

1. Focus (focus question), indicators include the following:
  - a. writing the information contained in the question.
  - b. identify or formulate questions appropriately.

2. Reason (Analyzing Arguments), indicators include the following:
  - a. Looking for formulations or alternatives to solve problems from a given math problem.
  - b. Identify the reasons clearly and precisely.
3. inference (deciding action), indicators include the following:
  - a. Decide what to do by solving the problem using a formula or alternative that has been designed.
  - b. Writing conclusions appropriately

However, the facts show that increasing critical thinking skills have not received special attention. The implementation of mathematics learning in schools is not fully oriented towards critical thinking skills. Until now, the attention to developing students' critical thinking skills is relatively low. Therefore, students' critical thinking skills, especially in mathematics in junior high schools, are relatively unsatisfactory. Based on the results of interviews conducted with mathematics subject teachers at Kartikatama Metro Junior High School, it can be concluded that the learning process carried out in the classroom is dominated by teachers so that students do not play an active role in the learning process. This is in line with the opinion of Schoenfeld in Kanzunudin, et al. (2013: 119) that conventional which teacher-oriented mathematics teaching results in students working procedurally (*monotonously*) and understanding mathematics without reasoning.

When referring to the current curriculum, this has not achieved the expected passing standard goals. So, there is a need for innovation, especially mathematics learning in order to improve students' critical thinking skills. The problem-based learning model is an alternative learning that pays close attention to students' intellection, including students critical thinking skills. This is supported by the opinion of Noer (2009: 479) that problem-based learning can improve students' critical thinking skills. This opinion is in line with the opinion of Nafiah and Suyanto (2014: 130) which states that the Problem Based Learning learning model is a learning model that can provide a learning environment that supports critical thinking. Based on these opinions, it can be concluded that the problem-based learning model can be alternative learning that fosters students' critical thinking skills.

Problem Based Learning is learning by giving problems to students. This is in line with Sujana (2014: 132) Problem Based Learning is a learning that presents a variety of problematic situations that are authentic and functional for students, so that these problems can be used as a stepping stone to carry out investigations and research. Based on the definition of Problem Based Learning put forward by some of these experts, it can be concluded that Problem Based Learning is a learning that emphasizes giving problems to students that must be solved through investigations to find solutions to these problems. Thus, Problem Based Learning is expected to improve students' critical thinking skills. This is supported by the opinion of Sunggur & Tekaya (2006: 308) that in the Problem Based Learning process, students are required to think critically, creatively, and monitor their understanding.

The syntax for problem-based learning models according to Arends (2012: 411) is as follows:

- a. Phase 1 (Provide orientation about problems to students).  
Students understand the learning objectives, describe various important logistical needs and are motivated to be involved in problem-solving activities
- b. Phase 2 (Organizing students so that they can do research).  
Students define and organize learning tasks related to the problem with the help of the teacher
- c. Stage 3 (guiding investigations independently and in groups).  
Students are motivated to obtain relevant information, carry out experiments, and seek explanations and solutions
- d. Phase 4 (Developing and presenting an artefact/exhibit).  
Students plan and prepare appropriate artefacts, such as reports, video recordings, and models and present them to others with the help of the teacher
- e. Phase 5 (Analyze and evaluate processes in solving problems)  
Students reflect on their investigations and the processes they use with the help of the teacher

However, from research conducted by Fakhriyah (2014: 100), it was found that the weakness of Problem Based Learning was found. Apart from inadequate time, another obstacle is that some students rely on their group friends. Problem Based Learning should require independent learning activities for every student. This is reinforced by the opinion of Nafiah and Suyanto (2014: 130) who state that Problem Based Learning is learning based on constructivist learning theory, where thinking and problem-solving skills can be developed if students do it themselves. So, one solution that can be used to overcome the problems of the model is to provide a stimulus that encourages students to rely on their thinking skills, namely by providing a metacognitive element in the problem-based learning model.

Metacognition is an awareness of their abilities, both the ability to understand, control and the ability to manipulate their cognitive processes (Yenti, et al. 2012: 170). The same thing is also expressed by Iskandar (2014: 14) that metacognitive skills are a person's skills in controlling the learning process, starting from the planning stage, choosing the right strategy according to the problem at hand, then monitoring progress in learning, and simultaneously correcting if there are errors that occur. occurs during understanding the concept, as well as analyzing the effectiveness of the chosen strategy. That is, in general, metacognitive learning refers to students' knowledge about their learning process. The definition of metacognitive skills can be positioned as a skill to be achieved as well as a process that needs to be developed. According to Siregar (2017: 4) metacognition is learning by forming an awareness of one's own cognitive, namely how cognition works and how to regulate it. These skills are important in the process of solving problems.

The same thing was also expressed by Kramarski and Zoldan (in Nurasyiyah, 2014: 117) that learning with a metacognitive approach is learning that instils awareness of how to design, monitor, and control and plan solutions to work on. Therefore, this learning is oriented towards learning activities. Meanwhile, the teacher plays a role in helping and guiding students when experience difficulties, as well as assisting students in developing their self-concept in the process of learning mathematics.

Based on the definition of metacognitive put forward by several experts, it can be concluded that metacognitive learning is learning where students can find out their cognitive skills, namely by exploring their abilities and weaknesses, and finding solutions to overcome the weaknesses themselves, so that they can solve a problem according to his skills. So, it can be concluded that Problem Based Learning based on metacognitive is a modification of a Problem Based Learning model that has integrated metacognitive traits into the Problem Based Learning steps. This learning is carried out by giving students problems that must be solved by involving traits that refer to metacognitive skill activities. The metacognitive activities are: activities that trigger students to explore the skills and information they have received, 2) be able to overcome their limitations or weaknesses, and 3) then solve a problem with their own skills.

## 2. RESEARCH METHOD

This study is a research & development. The development procedure refers to the Research & Development procedure from Borg & Gall, namely as follows: Research & Development from Borg & Gall, that is: Research and Information Collection, Planning, Develop Preliminary of Product, Preliminary Testing, Main Product Revision, Main Field Test, Operational Product Revision, Operational Field Testing, Final Product Revision, Dissemination and Implementation. However, in practice, this development procedure is limited to the Develop Preliminary of Product stage.

The subjects in this study were teachers and lecturers as learning experts. Experts have a role to assess the learning model developed. Data collection techniques used in this study include: interviews, observation, and questionnaires. The questionnaire instrument was a Likert scale statement with four answer choices, namely: 1 (very bad); 2 (less); 3 (good); 4 (very good). At the Research and Information Collecting Stage, researchers conducted preliminary research by conducting field observations in class VIII as a reference before the research was carried out, then looking for relevant sources to develop a problem-based learning model based on metacognitive. The planning stage is planning to develop a problem-based learning model based on metacognitive. Planning in the Research and development includes: formulating research objectives, estimating the implementation, capabilities and qualifications of researchers and the time required for research. The Develop Preliminary of Product stage is the activity of translating design specifications into physical form. After the product is made, then the product is validated by the expert. At this stage of the research, it seeks to present findings about the level of validity of the metacognitive-based problem-based learning model which is oriented towards improving critical thinking skills. To assess the validity, the researcher used a validation sheet which was filled in by three people: namely a mathematics teacher (*practitioner*) and 2 mathematics learning experts.

The questionnaire instrument is a Likert scale statement with four answer choices, namely: 1 (very bad); 2 (less); 3 (good); 4 (very good). The formula used to determine product validity is as follows:  $P = (\sum x_i) / (\sum x) \times 100 \%$

### Information:

$P$  : percentage

$\sum x_i$  : amount earned

$\sum x$  : total amount

The criteria for the level of product validity are as follows:

**Table 1.** Criteria for Product Validity Level

No.	Percentage (%)	Validation Criteria
1	76 – 100	Valid
2	56 – 75	Quite Valid
3	40 – 55	Less Valid
4	0 – 39	Invalid

The product developed will be said to be suitable for use if the percentage obtained is  $\geq 56\%$ , which is the minimum category that is quite valid.

## 3. RESULTS AND DISCUSSION

This development research produces a problem-based learning model based on metacognitive. Development research is carried out based on Borg and Gall's development steps. This development research produces a problem-based learning model based on metacognitive. The research started from the Research and Information Collecting stage which consisted of observation, interviews, and learning difficulties of students carried out in the 8th grade of Kartikatama Metro Junior High School and continued with interviews with the teachers who taught the 8th grade of Junior High Schools. The results of observations and interviews with teachers and students include: 1) The learning methods and models used by the teacher are conventional in mathematics learning, namely the teacher directly explains the subject matter and provides examples of questions and their solutions, and then students are asked to do the exercises given; 2) The teaching materials used are the mathematics books of Junior High School/ Islamic Junior High School 8th grade, curriculum 2013 revised edition 2018; 3) The teacher does not provide a stimulus to increase student activity. The teacher explains the subject matter and allows students to ask questions after completing explaining the subject matter; 4) Active participation is only dominated by certain

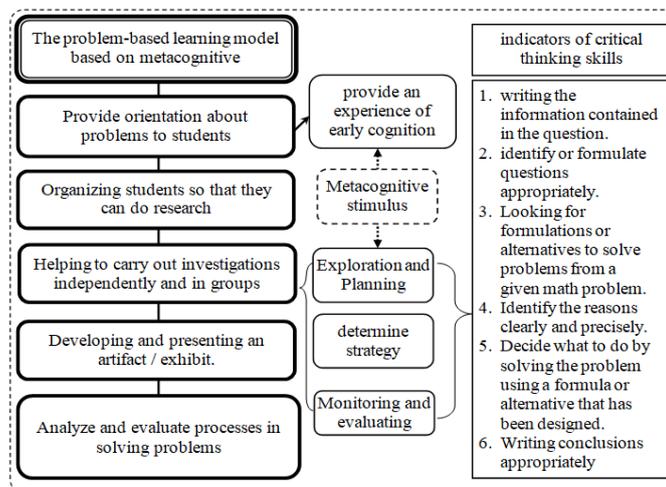
students. Meanwhile, other students tend to be passive in learning. 5) Students have difficulty when faced with questions that are different from the example questions described; 6) Students' mathematics learning outcomes in the form of daily test scores are still low.

Furthermore, the researchers collected the 2013 curriculum mathematics textbook and student worksheets (LKPD) that the teacher used when teaching to be studied, it was a reference for the preparation of student worksheets (LKPD) in problem-based learning model based on metacognitive. In addition, analysis Competency Standards (SK) and Basic Competencies (KD) of the subject matter, as well as review relevant research as an action literature study. Because the product to be developed in this study is a problem-based learning model based on metacognitive, therefore in this study relevant sources are sought to develop a problem-based learning model based on metacognitive. The next stage is Planning, where the researcher plans for the preparation of development. The development that will be carried out includes the development of a syntax of the problem-based learning model based on metacognitive along with supporting tools in the form of a syllabus, lesson plans, and student worksheet. The next stage is Develop Preliminary of Product, which is to design a learning model in the form of a book of the problem-based learning model based on metacognitive which is oriented towards critical thinking skills. The book contains the theory and syntax for developing a problem-based learning model based on metacognitive that includes a sequence of learning stages. After compiling the development of the model and supporting tools, then validated by an expert. The goal is to assess the instruments to be more effective or evaluate the possible deficiencies in the product. Validation consists of validating the learning model, validating the lesson plan (RPP), and validating student worksheets (LKPD). The validation of the learning model was carried out by a learning expert. The data on the results of the validation of the problem-based learning model based on metacognitive design are summarized in **Table 2**.

**Table 4.** Scores and Criteria for model design

Components	Items	Score Validator
Syntax	Item 1	4
	Item 2	3
	Item 3	4
Social System	Item 1	3
	Item 2	3
	Item 3	3
Principle of Reaction	Item 1	3
	Item 2	3
Instructional and Accompaniment Impact	Item 1	3
	Item 2	3
The number of scores obtained		32
the maximum number of scores		40
Percentage (%)		80 %
Validation Criteria		Valid

Based on **Table 4**. The results of the validation of the problem-based learning model based on metacognitive design obtained a percentage of 80% which is the valid criteria. then, revisions are made based on suggestions and input from experts. The suggestions from the validator are to clarify the impact of the herd and the instructional series of drafts for each learning stage. The validator also suggested that the learning syntax be adjusted to the implementation of metacognitive stimulant activities for learning mathematics. In the stage before the improvement of metacognitive stimulants of mathematics learning was carried out in phase 3 only, namely independent investigations only. After stimulant repair, metacognitive action also needs to be done in phase 1, which is to provide orientation about problems to students. The results of the revisions carried out are consulted again with the expert until a design of the problem-based learning model based on metacognitive is obtained which is declared feasible. The syntax design of a problem-based learning model based on metacognitive that is oriented towards critical thinking skills is described as follows:



**Figure 1.** Design of Problem-Based Learning Model Based on Metacognitive

Metacognitive activities are carried out at stage 3 in the problem-based learning model, which is guiding investigations independently or in groups. The steps for metacognitive activity are as follows:

- a. Each student is asked to determine a formula to solve the given problem (each member of the group is different). This activity is a form of exploration and planning activities
- b. Each student will explore his own skills by relying on the previous information that he has received. At this stage students will determine problem-solving strategies
- c. In turn, students in the group share solutions or formulas based on their respective ways. in this activity students will monitor and evaluate each other.
- d. Together to make corrections to the answers.

The validation of the lesson plan and students' worksheets was carried out by the subject matter expert. The recapitulation of the results of the subject matter expert validator's assessment of the lesson plan is obtained in **Table 5**.

**Table 5.** Scores and Categories of Results of the Validation of lesson plan (RPP)

Assessment Indicators	Assessment items	Validation Score
Competency Standards (SK) and Basic Competencies (KD)	Item 1	4
	Item 2	4
	Item 3	3
Learning indicators and objectives	Item 1	4
	Item 2	3
Preparation system of the lesson plan (RPP)	Item 1	3
	Item 2	4
	Item 3	3
Learning stages and instruments	Item 1	3
	Item 2	4
Use language in accordance with the customized spelling (EYD)	Item 1	3
	Item 2	4
	Item 3	3
Time Allocation	Item 1	4
	Item 2	4
The number of scores obtained		53
The maximum number of scores		60
Percentage (%)		88%
Validation Criteria		Valid

Based on **Table 5**, the overall lesson plan (RPP) meets the valid criteria so that it can be used with revisions. The suggestions from experts include: 1) the lesson plan (RPP) is recommended to use more standard language in learning activities. 2) Attach learning outcome assessment instruments to make learning easier. Improvements were made by adding attachments to learning assessment instruments in each meeting. The results of the revisions that have been made are then consulted again with the experts. The recapitulation of the results of the subject matter expert validator assessment of student worksheets is obtained in **Table 6**.

**Table 6.** Scores and Categories of Validation Results of Student Worksheets (LKPD)

Assessment Indicators	Validation Score	Max Score
Suitability of core competencies (KI) and basic competencies (KD) / 3 Item	10	12
Accuracy of lesson topics / 5 Item	19	20
Encourage curiosity / 1 Item	4	4
Presentment Technique / 2 Item	7	8
Completeness of Presentment / 3 Item	11	12
Encouraging Curiosity / 8 Item	6	8
Coherence / 2 Item	6	8
Total Number	63	72
Average		3,50
Percentage (%)		88%
Validation Criteria		Valid

Based on the recapitulation of the results of the subject matter expert validator assessment of student worksheets (LKPD) on the topic of the Three dimensional (3D) shape with flat surface, it appears that the student worksheets (LKPD) on the topic of the Three dimensional (3D) shape with flat surface meet the valid criteria. The suggestions from experts include: 1) fixing the use of the language used; 2) Fixing the picture to make it look real; 3) providing a more attractive student worksheet (LKPD) cover. The results of the revisions that have been made are then consulted again with the expert until a student worksheet (LKPD) is obtained which is said to be feasible and usable. The next step is practitioner validation. Practitioner validation was carried out by a mathematics teacher at school, namely Mrs. Sinta Lina Sari, S.Pd. Practitioner validation includes the design of learning models, lesson plans (RPP), and student worksheet (LKPD) on the topic of the Three dimensional (3D) shape with flat surface. The practitioner validation instrument is the same as the instrument used in the validation of learning experts and validation of subject matter expert. The recapitulation of the results of the practitioner's validation assessment can be seen in **Table 6**.

**Table 7.** Practitioner Response Score

Products	Score (%)	Conclusion
Learning Model Design	89 %	Worth using without revision
Lesson plan (RPP)	93 %	Worth using without revision
Student worksheet (LKPD)	90 %	Worth using without revision

Based on **Table 7**, it can be concluded that the overall problem-based learning model based on metacognitive along with lesson plan (RPP) and student worksheet (LKPD) on the topic of the Three-dimensional (3D) shape with flat surface are declared valid and suitable for use. Based on the expert's assessment, theoretically the problem-based learning model based on metacognitive can be an alternative learning that can improve students' critical thinking skills. The research results that support this research are the results of Noer's research which shows that the problem-based learning model can improve students' critical thinking skills (Noer, 2009: 479). The results of this study are also supported by the results of Listiani's research which shows that metacognitive learning based on open problems can improve mathematics learning outcomes (Listiani, 2014).

#### 4. CONCLUSION

Based on the results of development and validation assessments from experts, the development of metacognitive-based problem-based learning models are declared valid and suitable for use in the learning process. Theoretically, the problem-based learning model based on metacognitive can improve critical thinking skills, especially for class VIII students on the topic of the Three-dimensional (3D) shape with flat surface. Based on the above conclusions, the suggestions that can be considered are (1) For teachers, they can use a problem-based learning model based on metacognitive as an alternative to improve students' critical thinking skills on the topic of the Three-dimensional shape with flat surface; (2) For the next researcher, it is hoped that they can carry out further research with a problem-based learning model based on metacognitive.

#### AUTHOR'S CONTRIBUTIONS

The authors discussed the results and contributed to from the start to final manuscript.

#### CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

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