LKPD Development Using Open Ended Approach to Improve Students' Numerical Metacognition Ability

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Abstract. The research objectives: 1) Dissect on the improvement of students' numerical metacognition skills through LKPD with Open Ended learning; 2) Knowing the nature of LKPD with a quality Open Ended approach. The subjects of this study were students of class VIII SMP Bina Satria Mulia Medan, totaling 32 students. The research instrument was a test of students' numerical metacognition abilities. Data analysis was carried out using the Tessmer model of developmental assessment. In the results of experiment I and experiment II, there are: 1) LKPD that uses the Open Ended learning strategy to achieve indicators of validity, practicality and effectiveness; and 2) The test results of increasing the capacity of numerical metacognition using LKPD with Open Ended learning have been developed in terms of the typical N-gain value in the first experiment as much as 0.43 increased to 0.49 in the second experiment, meaning the "medium" category.

Keywords: LKPD Development, Tessmer model, *Open Ended* Approach, Numerical Metacognition.

1 Introduction

Math is a fundamental subject for students of all ages. According to Hasratuddin (2018), mathematics teaches people to think more systematically and analytically. (Cockcroft, 1982) makes the case that mathematics should be taught to students for the following reasons: (1) it is applicable to all aspects of life; (2) all fields of study require mathematical skills; (3) it possesses powerful, concise, and clear communication methods; (4) it can be used to present information in a variety of different ways; (5) it teaches logical thinking, thoroughness, and spatial awareness; and (6) it teaches students to be satisfied with their efforts to solve challenging problems. According to Cornelius (1982), who shares our sentiments, there are five reasons to study mathematics: (1) a method of thinking that is crystal clear and logical; (2) strategies for overcoming the challenges of day-to-day life; (3) strategies for discovering patterns of relationships and generalizing experiences; (4) strategies for fostering creative problem-solving; and (5) strategies for broadening one's cultural horizons.

"the contemporary aim of mathematics education is to master problem-solving ideas," as stated in Simamora, R. E., Saragih, S., and Hasratuddin (2018). The mathematics curriculum of the

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future should emphasize critical thinking, aesthetics, objectivity, and openness. It is imperative that students improve their mathematical abilities as a result of the widespread application of mathematics. If they put in the effort, students are capable of achieving good results. (1) Having an understanding of mathematical concepts, being able to solve problems in a manner that is adaptable, accurate, efficient, and precise, and being able to explain the relationship between mathematical concepts and algorithms; (2) The ability to reason about patterns and the nature of generalization, to construct proofs or to explain mathematical operations of mathematical thoughts and statements; (3) The ability to solve problems, including the capacity to understand problems, design, mathematics, and other topics that are related. (5) An appreciation for the importance that mathematics plays in everyday life, including the characteristics of inquisitiveness, attentiveness, and excitement in the study of mathematics, as well as adaptability in one's approach to the resolution of problems. The government has made considerable efforts to enhance mathematics education on the basis of these goals and the centrality of mathematics to the human experience. This may be observed in the efforts that the government is making to enhance curricula, increase the teaching capacities of educators, and generate high-quality intelligence and human resources.

There are several factors contributing to Indonesia's poor educational system. The potential for learning has not been brought to its full potential, and neither the materials nor the approaches that have been utilized are efficient. The Graduate Competency Standards (SKL) and Content Standards have been incorporated into the KTSP (Permendiknas No. 22, 23, and 24) curriculum that was implemented in 2006. (SI). Both SKL and SI place an emphasis on students' level of competency. The curriculum of KTSP stipulates that teachers are responsible for managing and producing learning resources in addition to serving as learning facilitators. In accordance with the requirements outlined in Article 20 of Government Regulation 19 of 2005, educators are required to plan and execute high-quality instructional procedures, as well as evaluate students' acquired knowledge. To meet these requirements, there is a pressing need to improve the standard of teaching, as well as the infrastructure of educational institutions, the resources available to students, and the laws that govern the field.

In order for students to acquire mathematics, they need to have mathematical metacognition. The National Council of Teachers of Mathematics (NCTM, 2000) identified five aspects of mathematical ability: the ability to communicate mathematical ideas, the ability to reason mathematically, the ability to solve mathematical problems, the ability to connect mathematical ideas, and the ability to represent mathematical ideas. According to the authors of the study, metacognition places an emphasis on self-monitoring and learner responsibility (Marzano, 1998). To self-regulate, plan, direct, and assess your actions. Students that use metacognitive methods develop the ability to learn independently much more quickly. According to the research, children can improve their learning outcomes, become more autonomous learners, have an honest attitude, and recognize their mistakes if they engage in metacognition (Susantini, 2004).

Students at SMP Negeri 20 Medan were found to have a low level of mathematical metacognition, as shown by the results of the observations that were carried out at the school. This is seen when the researcher gives an initial test to students in class VIII-1, and the students write down what they know, but they do not write down the questions that are being asked because they are unable to synthesize the information in order to update the model. This can be seen because the students are unable to update the model. Students are less careful when calculating the solutions because they do not know the formula for the problem, which causes

them to be confused when they are completing the procedures. As a result of this confusion, students are less likely to get the correct answers. After they have finished responding to the questions, they do not reevaluate the results, nor do they draw any conclusions based on the information provided by the responses.

According to the student responses that were obtained, specifically from the 32 students who were given this question, when viewed from the guidelines for scoring mathematical metacognition abilities in planning aspects with written indicators that were known, asked correctly, and completely, there was only one person who write down what was known and asked, with two people who were correct but incomplete, five persons wrote down what they knew and were questioned, and one person who write down what they knew and were questioned.

According to the explanation that was provided earlier, each stage of the mathematical metacognition test that a student takes is classified as because the majority of students achieve the lowest score possible on each indicator. Everyone in the class has a poor level of mathematical metacognition (59). According to (Arikunto, 2006), N88 is considered "high," 59N88 is considered "mid," and N59 is considered "low." The findings of mathematics assessments indicate that students' mathematical metacognition skills are not yet very advanced, so it is important for teachers to work on improving these skills. A questionnaire was used to evaluate the students' level of comprehension of the topic.

An approach to teaching and learning that is mundane or traditional is one of the factors that contributes to students' poor academic performance. According to the interview that the researcher had on June 23, 2021 with one of the math teachers at SMP Negeri 20 Medan, learning activities were carried out as usual, the teacher explained the topic, and students listened before completing practice problems. It is impossible to carry out educational activities in accordance with the RPP that is now in place; the most important thing is for pupils to comprehend the content and take in the instructor's expertise.

Teachers have a responsibility to make attempts to improve the field of mathematics learning in schools, particularly the mathematical metacognition of pupils, which contributes to subpar outcomes in students' mathematics learning. Enhanced Worksheet for the Students (LKPD). The Student Worksheet (LKPD) is a printed instructional resource in the form of sheets of paper that contain material, summaries, and directions for executing learning tasks that students are required to undertake in reference to Basic Competencies (KD). These sheets are printed on paper (Andi Prastowo, 2012). The Student Worksheet, also known as the Student Activity Sheet, has an impact on education and need to be in the possession of every educator.

Students are able to participate more actively and creatively in the learning process when they use student activity sheets, which also provide them with practice questions. Students can try learning on their own with the support of this. The activity sheet for students assists the instructor in facilitating the learning process, which can take a significant amount of time to explain. A approach for a teacher to get students ready for learning is by having them create student worksheets, often known as activity sheets. Student Worksheets, also known as Student Activity Sheets, provide assignments for students to do. These assignments are typically presented in the form of directions, steps to finish a task, and Basic Competencies (KD) that need to be attained. The process of teaching and learning benefits from careful lesson planning. This assertion is in agreement with (Hariyanto, 2013) "The success of an activity is primarily

dictated by its planning; if the planning is well-designed, the activity will be easier to carry out, lead, and regulate." [Citation needed]

Students are required to engage in high-level thinking question practice in Indonesia in order to strengthen their higher-order thinking skills (Rahayu, et al., 2018). Creating activity sheets for kids and enhancing their mathematical thinking both require a suitable learning strategy. For this study, open-ended learning was utilized. (Alhadad, 2010) The objective evaluation of pupils' high-level mathematical ability is the first step in the open-ended method. Students are engaged with open-ended questions that can have several valid answers using this approach. According to (Firdaus, 2016), the Open Ended method encourages students to enhance their creative abilities as well as their ability to solve mathematical problems. Every student is responsible for finding solutions to challenges that are tailored to their individual skills and areas of interest. Math activities may be fun for children of all skill levels, not just those with stronger mathematical aptitudes. The purpose of this instructional strategy is to improve students' mathematical metacognition by providing them with more leeway in their problem-solving approaches. These requirements can be satisfied by open-ended mathematical inquiry. The problem presents itself in the Open Ended methodology as having numerous correct responses. According to Becker (Oktaviani et al., 2017), this method teaches students how to locate, recognize, and solve problems by utilizing a variety of different strategies. Students build their own knowledge through the process of problem-solving and drawing on existing information in this form of learning, which is particularly constructivist. According to research conducted by Purwanto (2011), teaching students about exponential function graphs using a technique called Open Ended helps students become more creative and enhances their mathematical metacognition. The Open Ended method encourages students to acquire knowledge by the participation in authentic activities and the observation of natural occurrences. The presentation of phenomena can be made more transparent through the use of problem-oriented learning or open-ended questions. Mathematical learning should start with open problems, which are issues that have several correct solutions and multiple paths to get there.

According to the description given above, this issue is associated with the problems that result in students having a low level of mathematical metacognition ability. After that, there will be research done to find solutions to the problems that already exist by developing new educational materials. It was because of this that he decided to carry out a study with the working title "Development of HOTS-Based Student Activity Sheet with an Open Ended Approach to Improve Mathematical Metacognition of Students at 20 Medan Junior high school.".

2 Research methods

This research is for product development and testing. Tessmer development model is used to develop and verify the product. This model has two stages: preparation and prototype.

Class VIII-1 students at SMP Negeri 20 Medan in 2021/2022 participated in this study. This study developed an open-ended HOTS-based Student Activity Sheet for SMP class VIII. This class's students were studied.

Data Analysis of Learning Device Validity

Five education experts and practitioners provided this validation. The average value of each component will be calculated based on the professionals' opinions.

When using the open-ended learning approach, examine whether the learning tools require little or no revision. This can be determined by consulting experts. To examine the applicability of a learning device, give an assessment scale and validation sheet based on the open-ended learning model. Then you can form an opinion.

During the learning process, the application of various learning devices, and the provision of observation sheets, a trained observer watches the learning activity phases. This observer completes the learning implementation sheet. The assessment sheet for learning devices is formatted as a sequence of choices with a point value from one to five, with a score of five (very good), a score of four (good), a score of three (good enough), a score of two (not good), and a score of one (very good) all accessible (not good).

Data on student learning mastery, achievement of learning objectives, and student answers were utilized to analyze the effectiveness of the learning aids. Students' mastery of classical education basics is utilized to evaluate mathematical metacognition learning aids. The concept of minimum completeness is tested by considering that students are considered complete if their scores total 80. Class X KKM at SMA Negeri 1 Singkil is 80 points. A lecture is considered classical if 85% of test-takers score 80 or higher. It's a lesson necessity. Classical Completeness Percentage: 85% (PKK).

2.1 Data Collection Instruments and Techniques

Instruments for Assessing the Quality of Educational Resources

The learning device validation instrument is a sheet that is used to get the opinions of industry professionals on the level of quality offered by educational resources. Sheet for RPP Validation as well as Sheet for Student Activity This checkbox authorization form includes format, language, pictures, and content.

Instruments for Assessing One's Capability in Mathematical Metacognition

A structured description test is the assessment tool that is used for determining one's level of mathematical metacognition.

Student Response Instrument

The instrument that is utilized in the process of collecting responses from students is known as a student response questionnaire. The opinion or response of a student to the components and learning tools that were produced can be gathered through the use of a student response questionnaire. The methodology that is used to acquire data from student responses is carried questionnaires to students as the method that is used to carry out the methodology that is used in order to carry out the methodology that is used. The responses of students in this study are student perspectives on interest, feelings of pleasure, currentness, and interest, as well as the ease of understanding learning materials through learning tools built through the Open Ended learning model. This study was carried out in the United Kingdom. This study was conducted in the United States.

2.2 Learning Media Development Procedure

During this preliminary stage, you will be deciding where the research will be done and what it will focus on. The first step in applying this paradigm is to determine what the learning goals will be. The purpose of this exercise is to define the required competences in such a way that they may be mastered and applied by students once they have completed their education. This aim is established based on an analysis of how learning is implemented, on the results of the tests administered, and on the numerous learning challenges faced by pupils..

Self Evaluation

The process of development research enters its official phase after this stage, which marks the commencement of the stage. At this point, a preliminary analysis is carried out, which includes an analysis of students, with students in grades VIII-1 and VIII-3 serving as the target students, an analysis of the curriculum, which reveals the identification and systematic arrangement of concepts in the cube and block material to produce a concept map, and an analysis of the materials that are being utilized. The target students for this study are students in grades VIII-1 and VIII-3. Students in eighth grade, specifically grades eighth-1 and eighth-3, will be the focus of this research. will be created, and once it is done, it will be known as the HOTS-based Student Activity Sheet.

Prototyping

Experts (for the of expert evaluation) and students (on a one-to-one basis) are simultaneously presented with the outcomes of the design based on the prototype developed using the. The outcomes of both are incorporated into the revising process as material. The name for the product that emerged after making adjustments to the This is the second version of the prototype.

Expert Review

An examination of the product that had been designed was carried out during the stage of the expert review, along with assessment and evaluation by a panel of seven experts consisting of three mathematics education professors, two colleagues, and two mathematics study teachers. These experts examine each prototype with regard to the content, construction, and language of each version. After the information has been generated, it is subjected to revision utilizing the recommendations of specialists. At this stage in the process, Responses and suggestions from experts (validators) are written on the validation sheet as revision material and say if the design is valid. The validation sheet also indicates whether or not this design is valid.

One-to-one

A trial of the design was executed with the participation of six students who acted in the capacity of testers during the one-on-one stage. These students were separated into three groups based on the level of ability that each of them possessed: two of these students had low skills, two of these students had moderate abilities, and two of these students had high abilities. As a result of the findings obtained from this implementation, the design that has been developed has been modified.

Small group

The challenges that were encountered when The prototype's testing was used to create the second prototype. Revision was based on expert evaluation results. Next, the prototype was tested on nine students with poor, intermediate, and high abilities. These test, which were gained via its execution, are then utilized in the process of changing the trial in order to get it ready for the field test phase of the experiment. The findings of the research conducted on these things make up what is known as the third prototype. This arises as a result of the questions being altered as a reaction to the suggestions or observations made by the students in the smaller group.
Field test
The design of the second prototype is revised based on the feedback received from testing as well as any suggestions that were made second prototype Research participants tested the revision's results. This trial is a field test. Having been put through a field test are required to have satisfied the quality requirements in order to pass the test.
Validation/Expert assessment (Expert Appraisal)

In the course of this endeavor, specialists in their respective professions carry out evaluations. The process of getting recommendations for enhancement Evaluation of design-stage learning tools is referred to as expert validation. All of the components that make up the aforementioned teaching aids were created during the design phase of the project.

Trial of Research Instruments

A test of the students' metacognitive abilities with regard to mathematical concepts served as the research instrument that was used in this investigation. Before the research instrument could be used in the actual study, it was first put through its paces with a group of students who were not included in the sample. In addition to that, assessments of both validity and reliability were carried out. At this point in the process, one of our primary goals will be to construct a research instrument that is not only dependable but also usable in subsequent field tests. Building a reliable research instrument is one of our primary focuses at the moment.

Field Trial

Trials in the field were carried out in order to gather direct feedback on the learning tools that were being created before the production of the final tools. Learning aids that were supposed to improve students' metacognitive abilities and arithmetic skills were put through their paces in schools around the country to see whether or not they were both useful and successful.

Stage of Dissemination

At SMP Negeri 20 Medan's discussion forum for mathematics subject teachers, this activity was carried out in a constrained fashion. As a consequence of this stage's work, all of the mathematics subject instructors at SMP Negeri 20 Medan have been advised to suggest their students use this apparatus as an alternative method of learning about cubes and blocks.

3 Result

3.1 Validation of learning tools by using open ended learning tools by using developed tools

Throughout the entirety of this investigation, a mathematical metacognition ability test served in the capacity of a research instrument. A group of students who were not a part of the sample were used to conduct an initial test of the study instrument before it was put to use. After that, an analysis was carried out to determine the validity and reliability of the research instrument. The goal of this project is to develop a research instrument that is not only trustworthy but also flexible enough to be utilized in a variety of contexts. The following is a summary of the results of the validity and reliability test performed on the instrument:

We used a technique called product moment person correlation to try to establish whether or not the queries were genuine. To be more specific, we accomplished this by establishing a connection between the score on each item and the score overall. This allowed us to more accurately evaluate the data. The results of the mathematical metacognition ability tests that were given to the students are summarized in Table 1 which can be found below.

Table 1. Validity of posttest items for mathematical metacognition ability

Test Items	r_{xy}	t_{count}	t_{table}	Interpretation
1	0,9169	9,746	0,444	Valid
2	0,8661	7,351	0,444	Valid
3	0,9382	11,501	0,444	Valid
4	0,865	7,313	0,444	Valid

According to the findings of the validation carried out by specialists and practitioners in the field, it falls inside the valid category. In order to make the instructional tool usable, but with

some minor adjustments necessitated by the recommendations made by the specialists. The compilation of the outcomes of the validation efforts made by the five validators is presented in the table 2 that can be seen below:

Table 2. Learning tool validation results

No.	Rated object	Average Value of Total Validity (V_i)	Category
1	Learning Implementation Plan	4,320	Valid
2	Student Activity Sheet	4,20	Valid

Effectiveness of Student Activity Sheet Achieved by the Application of Metacognition Capability Using a Strategy for Learning That Allows for Open-ended Exploration

Student Activity Sheets and other open-ended HOTS-based test instruments can be utilized to improve learning. Student Activity Sheet and HOTS-based test instruments must meet the effectiveness criteria: (1) learning mastery (if it has a minimum absorption capacity of 75%, while classical completeness is achieved if 80% of students pass); (2) learning objectives mastery (a minimum of 75% of the formulated learning objectives can be achieved by a minimum of 65% of students); and (3) classical completeness (if 80% of students pass). Following is a discussion of each indicator for measuring Student Activity Sheet and HOTS-based test instruments utilizing Open Ended trial. I. On the metacognition test, nine pupils scored exceptionally high before and 17 after. Posttest: 10 kids meet high criteria, vs 8 before. Both assessments measure mathematical metacognition. 11 pupils had intermediate math metacognition pre-test, 5 post-test. The pretest fails four mathematicians. Posttest fails no students. Pre- and post-test data show no pupils have low mathematical metacognition. 16 pupils (50%) passed the pre-test; 24 (75%) passed the post-test. According to effectiveness standards, classical completeness must be 75%, hence the first trial's classical mastery test results failed.

If student activity sheets and open-ended HOTS-based assessments increase learning, employ them. The student activity sheet and HOTS-based test instruments must meet the effectiveness criteria: (1) learning mastery (if it has a minimum absorption capacity of 75%, while classical completeness is achieved if 80% of students pass); (2) learning objectives mastery (a minimum of 75% of the formulated learning objectives can be achieved by a minimum of 65% of students); and (3) classical completeness (if 80% of students pass). The Open Ended trial technique II is used to measure the effectiveness of the student activity sheet and HOTS-based test instrument. 13 students finished the pretest (40.62%) and 23 completed the posttest (76.66%). This signifies pupils' second classical mastery test scores met all requirements. Learning objectives were met in the second field experiment's post-test.

Learning time using the student activity sheet in trial II open-ended learning is the same as normal up to this point, six meetings with basic competencies. (2) Problem-solving with open-ended cubes and blocks. The second trial learning time has been met because minimal learning takes as long as standard learning. According to the second trial's data, the created educational resources were successful.

3.2 Improving students' metacognitive ability

The analysis of increasing students' mathematical metacognition in the first trial will be seen through the N-Gain from the pretest and posttest. Table shows N-Gain outcomes for mathematical metacognition:

Table 3. Summary of N-Gain results of mathematical metacognition ability trial I

N-Gain	Interpretation	Total students
$g \leq 0{,}3$	Low	10
$0{,}3 < g \leq 0{,}7$	Medium	19
$g > 0{,}7$	Hight	3

Table 3 shows three students with high N-Gain scores. 19 students improved in the medium category (0.3 g0.7 N-Gain) and 10 improved in the low category (g0.3). First experiment "middle" averaged 0.43. Mathematical metacognition markers are 0.619, 0.373, and 0.266. Evaluation has the lowest N-Gain (0.266), whereas planning has the highest (0.619).

The second trial's pre- and post-test results will be used to calculate the N-Gain, which will be used to analyze whether students' abilities increased. Table 4 summarizes N-mathematical Gain's metacognition :

Table 4. Summary of N-Gain results of experimental mathematical metacognitive ability II

N-Gain	Interpretation	Total students
$g \leq 0{,}3$	Low	10
$0{,}3 < g \leq 0{,}7$	Medium	17
$g > 0{,}7$	Hight	5

3.3 Improved mathematical metacognition ability

Posttest study found that metacognitive abilities improved in both treatments. Mathematical metacognitive skills improve between pre- and post-tests. The first trial averaged 62.89 in mathematical metacognition, then 77.93. This is the math metacognition analysis. In the second experiment, students' math metacognition scores rose 57.94 points to 76.76. Mathematical metacognition improved between trials I and II. Combining the exercise sheet and Open Ended approach boosts math metacognition.

The Ministry of National Education recommends contextual learning to help pupils understand subject matter (Sofnidar, 2017). (Social, personal, cultural) This helps pupils transmit their knowledge and abilities.

Problem-based learning encourages student participation so they can apply learned knowledge to family, community, or other situations. A learning technique like this helps kids develop mathematical thinking abilities, intellectual discipline, and curiosity.

When employing the Open Ended technique, students must reason about what they know to gain knowledge. If kids aren't taught to think, math will be seen as material that follows procedures and imitates instances without understanding them. Open-ended math can boost metacognition. The Open Ended approach can improve students' mathematical metacognition, according to Lestari, Selvia, and Layliyah (2019). Open-ended learning helps improve junior high pupils' mathematical metacognition and habits of mind, according to Zakiah Nur Eva (2014). Studying Malaysian pupils. This increased mathematical metacognition through easy-to-use Learning Implementation Plans for teachers and students, easy-to-implement Open Ended stages, and easy-to-understand student worksheets.

4 Conclusion

Open-ended HOTS worksheets boost arithmetic metacognition. The RPP's total validity is 4.320, and the LKPD's is 4.20. 2) Based on implementation findings, the HOTS-based LKPD with an open-ended approach seems practicable. First of 2.752 ("Possibly Implemented") failed research success criteria. After adjustments, the second trial's learning implementation observation score was 3.73. (category "Well Implemented"). 3) HOTS-based worksheets with an open-ended approach to promote mathematical metacognition, including classical learning completeness. First trial metacognitive abilities were 50% (16 students) (26 students). Mathematical metacognition learning objectives weren't reached in the first trial. 79%, 88%, 80.4%, and 76% attained learning objectives in the second experiment after many changes (complete). First, 90.85% of students reacted positively, then 92.744% did. Trials I and II raised students' math metacognitive ability by 0.04. Trial II (0.47), which begins with planning, chooses the right strategy, and analyzes learning and errors, has a higher average value than trial I (0.43). understanding.

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