DEVELOPMENT OF TEACHING MATERIALS BASED ON AN ICT ASSISTED METACOGNITION APPROACH TO IMPROVE STUDENTS PROBLEM SOLVING AND SELF REGULATED LEARNING ABILITY

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Abstract

This study is a research on the development of teaching materials based on the ICT-assisted metacognition approach to improve students' problem-solving and self-regulated abilities. The teaching materials were designed so that they meet the valid, practical, and effective criteria. This research was conducted at SMP Al-Washliyah 1 Medan, Indonesia. The findings of this study are: (1) Teaching materials based on the metacognition approach have met valid, practical, and effective criteria in increasing students' mathematical problem solving abilities and self-regulated students, (2) Increasing problem solving using teaching materials based on metacognition approaches that are ICT has been developed and assisted, seen from the N-gain value in the first test of 0.36, increasing to 0.50 in the second test, (3) Increasing self-regulated students after learning using teaching materials based on the metacognition approach that has been developed and ICT-assisted based on the overall average of the self-regulated questionnaire in the first test of 2.98, increasing in the second test to 3.25, (4)
Keywords: metacognition approach, problem solving ability, self-regulated, mathematics teaching tools

1. Introduction

Education that is able to support future development is education that is able to develop the potential of students. Naturally, the development of students varies, both intelligence, talents, interests, creativity, emotional maturity, personality, independence, physical and social. In the face of rapid technological developments, reliable human resources who have the ability and skills and high creativity are required. However, according to Trianto (2010: 2), the reality in the field shows that most school graduates are less able to adapt to changes and technological developments, are difficult to retrain, are less able to develop themselves and lack in work which means they have no creativity.

Mathematics is a subject that plays a very important role in education. Because in addition to being able to develop critical, creative, systematic, and logical thinking, mathematics has also contributed to everyday life ranging from simple things such as basic calculations to complex and abstract matters such as the application of numerical analysis in engineering and so.

According to the National Council of Teachers Mathematics (NCTM: 2000) the objectives of learning mathematics are to develop: the ability to explore, construct conjectures; and compile logical reasons, the ability to solve non-routine problems; the ability to communicate mathematically and use mathematics as a communication tool, the ability to connect mathematical ideas and between mathematics and other intellectual activities. In order to make learning mathematics easier, the teacher center teaching mathematics and the use of formulas alone must be abandoned so that students' mathematical abilities develop properly.

One of the mathematical abilities that need to be improved is problem solving skills. Problem-solving ability is one aspect of high-level abilities and is a central goal in learning mathematics. Problem is a statement indicating a challenge but cannot be solved by a routine procedure known to the perpetrator. The same thing was also stated by The National Council of Supervisors of Mathematics (in Hough, 2005: 2) that “problem solving is the process of applying acquired knowledge to new and unfamiliar situations. Problem solving strategies involve posing questions, analyzing situations, translating results, allustrating results, drawing diagrams, and using test anf error ”. Problem solving is the process of applying previously acquired

knowledge to new situations. Problem-solving strategies involve challenging questions, analyzing situations, translating results, describing results, drawing diagrams, and experimenting. So it can be concluded that problem solving there are routine activities which include challenging questions, analyzing situations, translating the results supported by strategies given by the teacher to develop, improve, and foster creativity.

Problem solving is the foundation of all mathematics and the process of discovering new knowledge. Problem solving ability is a very important skill in everyday life. Because, we are never free from problems. The importance of ability to solve this problem is in line with the opinion of Vettleson (2010: 1), "in the discipline of mathematics, the use of prblem solving skills has been extremely important and highly influential. Problem solving is the foundation of all mathematical and scientific researchie. ”In the mathematical discipline the use of problem solving skills has a very important effect.

Developing problem-solving skills requires a good cognitive structure, students must improve their cognitive processes in understanding problems and looking for problem-solving strategies. This is explained in the research of Yildirim and Ersozlu (2013) which states "Problem solving must include both cognitive and metacognitive processes because a problem solving individual has to select a strategy and think of alternative strategies as they come across difficult and changing situations", which contains meaning in problem solving includes cognitive and metacognitive processes, because in problem solving students must choose strategies and think of alternative strategies used.

Solving math problems also requires a willingness to learn. Because without the willingness to learn, it is impossible for students to be able and willing to solve math problems. Willingness to learn can be in the form of motivation to learn. Pintrich (Arends, 2001: 142) sees that motivation comes from the Latin verb movere and refers to "what makes an individual move" towards certain activities and tasks. When students are motivated in terms of learning, the results they will get will also be better than before. However, most students do not have the motivation to learn, especially in mathematics. Students will experience difficulties in learning so that students avoid learning because they are not ready to learn. Students' learning motivation can be seen from their learning independence. Independent learning is known as self-regulated learning.

Self-regulated learning (independent learning) is self-regulation or processing. Self-processing is in the form of the ability to regulate its behavior. Zimmerman (in Latipah, 2010: 111) says that Self-regulated learning emphasizes the importance of personal responsibility and controlling acquired knowledge and skills. Self-regulated learning makes students active in a class where students look for ways to acquire knowledge. The activeness of these students also affects their problem-solving abilities. Students can build their knowledge through self-regulated learning. This is in accordance with constructivism theory where students construct their own knowledge. Self-regulated learning gives students the freedom to acquire their knowledge. Through self-regulated learning, students can find appropriate ways to use them in learning.

According to Tafonao (2018: 104) there are several reasons why teachers do not use learning media. The first reason is (1) The teacher thinks that using media requires preparation. (2) Media is sophisticated and expensive. (3) Unusual to use media (stuttering technology). (4) Media is only for entertainment, while learning must be serious. (5) In schools the media is not available, the school does not have the equipment and materials to make learning media. (6) The teacher does not understand the importance of using learning media. (7) The teacher does not have the knowledge and ability about how to make their own learning media. (8) The teacher does not have the skills to use learning media. (9) The teacher does not have the opportunity (time) to make learning media. (10) Teacher is used to relying on the lecture method.

The rapid development of technology and communication in education gives birth to technology in education which will make it easier for us to advance the world of education. The use of media in the form of software helps the effectiveness of the learning process and the delivery of information at the early stages of learning. Visually, students' senses will be more active during the learning process because students can directly develop material on the media in the form of software that is in accordance with the material being studied. One of the media products that resulted from the development of ICT is macromedia flash.

The above problems require a learning solution that can solve all the problems faced by students, especially the problem-solving ability and student learning independence. The use of relevant teaching materials supported by appropriate media is one solution that can help teachers improve students' abilities in solving given problems.

One of the possible alternatives to improve students' problem-solving abilities and learning independence, so that students are able to understand concepts with awareness of thinking in the learning process in the classroom is a metacognition approach. According to Fauzi (2011), the concept of metacognition is awareness of thinking, including awareness of what a person knows (metacognitive knowledge), what a person can do (metacognitive skills), and what a person knows about one's own cognitive (metacognitive experience).

Schoenfeld (1992: 38) states that metacognition includes knowledge about thought processes, self-awareness, and beliefs and intuition. These metacognition aspects can help students solve problems. This is in line with the research of Setyadi, Subanji, and Muksar (2016) which states "Conceptually the metacognition is defined as knowledge or awareness of one's thinking process, an ability to monitor and manage the thinking process and its results, as well as evaluate the thinking. process and its result ", which contains the meaning of the concept of metacognition as knowledge or awareness of the thought process and the results of its thoughts, as well as evaluating the thought process and the results of its thinking.

The metacognition approach is a learning approach that is able to encourage students to construct their mathematical ideas in solving math problems. Based on research conducted by Hasan (2015), it is said that the metacognition approach has a high effect on improving student academic achievement. Then, Partanen, Jansson, Lisspers, and Sundin (2015) state that the metacognition approach consists of monitoring strategies used in different stages of learning, and planning completion as tasks, making summaries, and evaluating after completing tasks.

In addition, in learning mathematics the most important thing to emphasize is the skills in the thinking process. Students are trained to be able to develop logical, analytical, systematic, and consistent thinking skills. To assist in this thought process, in addition to the existence of an effective learning approach, pictures or animations can also be used. ICT (Information and Communication Technology) or in English is called ICT (Information and Communication Technologies) can play a role here. Learning mathematics using technology-based media is very good if we support it with an attractive and creative appearance so that it will help students understand and absorb the material being taught. One of the technology-based media that can be used in mathematics learning is macromedia flash.

Macromedia flash is an application program that can be used to design motion animation, form animation, multimedia presentations, games, interactive quizzes, simulations / visualizations and can be converted and published into several types such as * .swf, * .html, * .gif, * .jpg, * .exe, and * .mov. However, the reality in the field of using media in mathematics learning has not been applied at all at SMP Al-Washliyah 1 Medan. So that the use of Macromedia flash in mathematics learning in class is a new innovation in mathematics learning, because it is known that in class mathematics learning is conventional without using adequate media. Learning activities are dominated by teachers so that students feel bored, but by using Macromedia flash students can develop better learning methods. The learning approach must be oriented to the needs of today's technology, meaning that every material that has been designed in the curriculum description is looking for a link with technological problems. This is in accordance with Cahyo (2008) that: "Current technological developments require the use of computers in the learning process in schools as a medium of learning or educational media. This development research refers to the 4-D teaching material development model proposed by Thiagarajan and Sammel in 1974 which consists of four stages, namely the stage of defining, designing, developing, and distributing. (disseminate). The 4-D development model is used by researchers because the basis for implementing the development of teaching materials (not a learning system), the stages of implementation are divided in detail and systematically, and in its development it involves expert judgment so that before field tests the teaching materials have been revised based on the assessment , expert advice and input. Based on the above problems, the researcher wants to conduct research on "Development of Teaching Materials Based on the ICT-Assisted Metacognition Approach to Improve Students' Problem Solving Ability and Self Regulated Learning".

2. Theoretical Framework

The theories that form the basis of this research include Kemampuan Pemecahan Masalah, *Self-regulated,* Bahan ajar berbasis pendekatan metakognisi, and mathematics teaching tools.

2.1 Problem solving skill

Problem solving in mathematics is one of the learning outcomes to be achieved, and it is very important. In fact, it is often said that problem solving is the heart of mathematics. Problems in learning mathematics are questions that must be answered or responded to, but not all automatic statements will be a problem. A statement becomes a problem if and only if it indicates a challenge that cannot be solved by a routine procedure with which the student is familiar.

Napitupulu (2008) states that problem solving is one of the most important forms of learning in mathematics. Through problem understanding students can practice and integrate the concepts, theorems and skills that have been learned. Furthermore, he also said that teaching students to solve problems allows students to be more analytical in making decisions in life

According to Dahar (2011) problem solving is a human activity that combines previously acquired concepts and rules and is not a generic skill. Where by completing a problem, we already have new abilities or knowledge. And this ability can be used to solve relevant problems, the more we solve a problem, the more abilities we already have.

Solving problems in the form of stories means applying theoretical knowledge to solve real problems according to everyday situations. To understand this, the teacher can ask students to express their opinions in their own language. The teacher can check whether there are terms that may not be known or forgotten. Story questions can be done directly without any pictures because from these problems students can more or less understand them. If the questions are in the form of pictures, the teacher puts more emphasis on students understanding the pictures and weaving them back into the story questions, because students can understand and understand the elements in the pictures.

The essence of learning to solve problems is that students are accustomed to working on questions that do not only rely on good memory, but are expected to relate to real situations that they have experienced or have thought about. Then students explore with concrete objects, then students will learn mathematical ideas informally, then learn mathematics formally.

Good problem solving has a good impact on the behavior of students' daily lives. By familiarizing students with problem-solving abilities, students can practice thinking skills of students in finding solutions or solutions to a given problem. It can be concluded that problem solving in mathematics is the process of solving problems in mathematics related to real life that students experience or have thought about.

According to George Polya (in Hasratuddin, 2015: 18), heuristic techniques (help to find) include: (a) understand the problem; (b) foreign exchange plan; (c) carry out the plan; (d) look back. There are four techniques for finding or solving problems including: understanding the problem, making a problem-solving plan, executing the solution plan, and checking the results of the solution.

Based on this explanation, it can be concluded that mathematical problem solving is the process of solving problems in mathematics related to real life experienced by students or those that have been thought of through 4 stages of solving, namely: (1) understanding the problem in the form of a story problem first; (2) create a problem solving plan (determine the formula or concept to be used); (3) carry out the designed plan (using formulas or concepts in solving problems).

2.2 *Self-regulated*

Many psychologists provide a variety of definitions of independent learning or self-regulated learning (SRL), one of which is the opinion of Pintrich (2000: 453) that learning independence is a constructive and active process in which students set goals in learning, and try to monitor, regulate and control. cognition, motivation, and behavior are guided and limited by goals and contextual characteristics in the environment.

According to Knain and Turmo (2000: 101) self-regulated learning is a dynamic process in which students build knowledge, skills, and attitudes while studying a specific context. Furthermore, Zumbrunn, Tadlock, and Roberts (2011) state that independent learning is a process that helps students manage thoughts, behavior and emotions to make their learning experience successful.

Based on the description above, it can be concluded that independent learning is a process where students are able to independently adapt actively, determine their learning goals, monitor, control, utilize and determine learning resources and the learning strategies they need to maximize their abilities.

According to Yamin (2013), independent learning does not mean learning alone, the most important thing is to increase the willingness and skills of students in the learning process without depending on teachers or friends. Student learning independence emphasizes the initiative or desire of students to apply their thoughts, strategies and behavior to achieve learning goals.

2.3 Teaching Materials Based on Metacognition Approach

Metacognition was first put forward by Jhon Flavell, (in Usman, 2014) states that "metacognition literally thinks about thinking (thinking about thinking)". According to Fauzi (2011), the concept of metacognition is awareness of thinking, including awareness of what a person knows (metacognitive knowledge), what a person does (metacognition skills) and what a person knows about one's own cognitive (metacognition experience). Furthermore, according to Bajar-Sales, Avilla and Camacho (2015) metacognition is knowledge about a person's ability to control his thinking process in solving problems.

From the above opinion, metacognition is meant as the ability to realize one's potential. Know what he knows about something so that he can use the experience he has to make decisions about what to do.

One of the efforts to raise awareness of students' cognition is to provide directions for students to ask themselves. This is done so that students can monitor their understanding of what is being learned. So that students are able to carry out dialogue with themselves whether they understand what they are learning or thinking. In addition, students also ask themselves whether they recognize or know what they think in an effort to find a solution when they are faced with a problem. Because in order to develop their metacognique skills, students are required to observe what they know and do. When a person's development of metacognition abilities is less than optimal, he will have difficulty recognizing a problem. For this reason, a metacognition approach needs to be applied to train students' thinking awareness.

2.4 Mathematics Teaching Tools

Teaching materials are elements of learning that are considered by the teacher. Through these teaching materials students can learn things that are needed in an effort to achieve learning goals. For this reason, the determination of teaching materials must be in accordance with the objectives that are expected to be achieved in the form of knowledge, skills, attitudes or other experiences.

According to Hamdani (2011) teaching materials are information, tools and / or tels needed by educators. The goal is to plan and study the implementation of learning so that it helps educators carry out learning activities in the classroom. Meanwhile, mathematics teaching materials are a set of school mathematics materials needed by educators, which are systematically arranged, written / unwritten, to create a learning atmosphere for students so that they can master the subject matter completely.

In line with the opinion of Majid (2011) which states that teaching materials are information, tools, text and written materials or unwritten materials used by educators in teaching and learning activities for the implementation of learning. Teaching materials allow students to learn competencies systematically so that they are able to master competencies in an integrated manner.

Through teaching materials students can learn the things needed in an effort to achieve learning goals. Good mathematics teaching materials must make it easier for students to understand mathematics material. Math teaching materials are not only useful for students, but also for educators. If the teaching material has been prepared by the educator, the next step is to apply it well in class. Understand the material well so as to achieve learning goals. Therefore, mathematics teaching materials are the minimum materials that must be mastered by students, and must be able to attract the attention of students to read them. Teaching materials can be written or unwritten teaching materials. With the existence of teaching materials, learning activities will be more interesting, and provide opportunities for students to learn independently and make it easier for students to learn every competency that must be mastered.

Dedeng (in Harijanto, 2007) one of the important components in learning is teaching materials. One of the initial activities in improving learning is designing teaching materials that refer to a development to make learning easier. Prastowo (2013) states that teaching materials are in fact the form of all materials (both information, tools, and text) that are arranged systematically, which displays a complete figure of competencies that will be mastered by students and used in the learning process with the aim of planning and

studying the implementation of learning, while Abidin (2014) defines teaching materials as a set of facts, concepts, principles, procedures, and / or generalizations designed specifically to facilitate maintenance.

With teaching materials that allow students to learn competencies systematically and systematically so that the accumulation is able to master all competencies as a whole or in an integrated manner. For this reason, it is very important for teaching staff to have competence in developing learning materials that are in accordance with the required needs, so that learning materials can be conveyed well, as well as students who have sufficiently good learning activities.

From the description above, it can be stated that teaching materials are facts, concepts, principles, procedures and / or generalizations in the form of information, tools, or texts that are systematically designed to facilitate the learning process in order to achieve predetermined competency standards. Teaching materials that are developed and packaged properly will allow teachers to avoid the habit of presenting material from only one source.

3. Research Methods

3.1 Research Design

Based on the formulation of the problem and the stated research objectives, this research is categorized into the types of development research. This study uses a 4-D development model (defining, designing, developing, and disseminating) Thiagarajan, Semmel and Semmel (1974) by developing learning tools with a problem-based learning model. This development is carried out to produce teaching materials based on the ICT-assisted metacognition approach which will then be tested in class using the The One-Class Pretest-Posttest Design design, by not using a comparison class but already using pre-test so as to increase the students' problem and cell-controlled abilities. can be known for sure.

According to Thiagarajan (1974: 5) The 4D development model consists of 4 stages, namely: (1) the defining stage, aims to determine and define learning needs, (2) the design stage (design), design the design of teaching material prototypes, (3) the development stage, which aims to produce teaching materials, (4) the dissemination stage, namely the stage of using the developed teaching materials.

3.2 Subject of The Research

The subjects in this study were students of Madrasah Tsanawiyah Negeri Balige in the academic year 2020/2021.

3.3 Data Collection Technique

Learning devices are assessed based on the criteria Nieveen (1999) suggests criteria in assessing the quality of learning based on three aspects, namely: validity, practicality, and effectiveness. To measure the validity, practicality and effectiveness of mathematics learning tools, a research instrument was compiled and developed.

3.4 Validity and Reliability

Validity is a characteristic that must be possessed by the mathematical connection ability test and the mathematical creative thinking ability test, as well as the completeness of teaching materials, namely the Learning Implementation Plan (RPP), Student Activity Sheet (LAS), and Student Book (BS). This validation sheet contains the components assessed including: format, language, illustrations, and content. The reliability of the research instrument was obtained through the Cronbach alpha test.

3.5 Data Analysis

Data obtained from observations and assessments need to be processed to draw research conclusions. To ensure that the data obtained is not in doubt, the data needs to be tested to see its validity. Based on this validation, it can be concluded whether the teaching material is suitable for use or needs to be revised. Validation is only limited to content validity.

In analyzing the data, inferential statistics were also carried out to analyze differences in students' mathematical problem-solving abilities through teaching materials before and after being developed, as well

as descriptive statistical analysis to analyze the practicality and effectiveness of the teaching materials that have been developed.

4. Result and Discussion

4.1 Result

a. Data on the test results of mathematical problem solving abilities

Data posttest of students' mathematical problem solving abilities presented in Table 1 below:

Table 1. Data Improvement of Students' Mathematical Problem Solving Abilities

	Test I	**Tes II**	**Difference**
The Highest score	93,75	95,31	1,56
Average	74,19	82,66	8,47
The Lowest Value	62,50	70,31	7,81

From Table 1, it shows that the average mathematical problem solving ability of students in the results of the posttest I is 74.19. And the average of students' mathematical problem solving abilities in the results of the posttest II was 82.66. This shows that the average increase in students' mathematical problem solving abilities from experiment I to experiment II is 8.47.

The improvement of students' mathematical problem solving abilities in the first test will be seen through the N-Gain of the pretest and posttest results of mathematical problem solving abilities in the first test. And the increase in students' mathematical problem solving abilities in the second test will be seen through the N-Gain of the pretest and posttest results of mathematical problem solving abilities in the second test. The results of the calculation of N-Gain on mathematical problem solving abilities can be seen in the following table:

Tabel. 2 Rangkuman Hasil *N-Gain* Kemampuan Pemecahan Masalah Matematis

Range	**Test I**		**Test II**	
	Interpretation	**Total Students**	**Interpretation**	**Total Students**
$g \leq 0,3$	Low	1	Low	0
$0,3 < g \leq 0,7$	Middle	31	Middle	29
$g > 0,7$	High	0	High	3

Based on table 2. above, it can be seen that students who got an N-Gain score in the first test were students who experienced an increase in their mathematical problem-solving abilities in the "Middle" category or got an N-Gain score of $0.3 < g \leq 0.7$ as many as 31 1 person and students who experienced an increase in mathematical problem solving abilities in the "Low" category or got an N-Gain score of ≤ 0.3 were as many as 1 person. The average N-gain in the first test was 0.36, which is in the medium category.

And for the second test it can be seen that there were 3 students who got N-Gain scores in the range> 0.7 or experienced an increase in their mathematical problem solving abilities in the "High" category. There were 29 students who experienced an increase in mathematical problem solving abilities in the "Middle" category or got an N-Gain score of $0.3 < g \leq 0.7$ and there were no students who experienced an increase in mathematical problem solving abilities in the "Low" category or got a score. N-Gain $g \leq 0$. The average N-gain in the second test was 0.5, which is in the medium category.

b. Data S*elf-Regulated*

The student learning independence scale is an instrument that is structured to determine the ability of students to learn independence. In this study, the scale was given to students after completing a test of mathematical communication skills because the independence of students when doing the test was also measured in this questionnaire. This learning independence scale consists of 30 statement items. Each item of the statement is arranged in accordance with the indicators of learning independence that have been set by

the researcher. Each indicator of learning independence contains positive statements and negative statements that are randomly distributed on the learning independence scale.

The description of student learning independence can be seen through the average scale of student learning independence in the first trial for each indicator in Table 3.The following:

Table 3. Percentage of Student Learning Independence Scores in Test I

No	Indicator	Average Score	Categori
1	Learning initiatives	75,52 %	High
2	Diagnose learning needs	76,17 %	High
3	Set learning goals	76,17 %	High
4	Monitor, organize and control learning progress	75 %	High
5	View adversity as a challenge.	69,92 %	Middle
6	Make use of & search for relevant sources	73,05 %	Middle
7	Implement and select learning strategies	73,96 %	Middle
8	Evaluate	80,86 %	High
9	Self concept	72,92 %	Sedang

Based on the results of the second trial, it was found that the students' learning independence scores were as follows.

Tabel 4. Percentage of Student Learning Independence Scores in Test II

No	Indicator	Average Score	Categori
1	Learning initiatives	82,42 %	High
2	Diagnose learning needs	83,20 %	High
3	Set learning goals	80,85 %	High
4	Monitor, organize and control learning progress	80,72 %	High
5	View adversity as a challenge.	77,34 %	High
6	Make use of & search for relevant sources	80,85 %	High
7	Implement and select learning strategies	79,94 %	High
8	Evaluate	83,98 %	High
9	Self concept	82,55 %	High

Based on Table 3 and Table 4, it can be seen that there is a change in the percentage of students' learning independence scores.

4.2. Discussion

a. Learning Tool Development

For practical assessment, then it is reviewed from the teacher and students who state that the teaching materials developed are easy to use. Then, the criteria for practicality in terms of the implementation of the teaching materials in this study have also met the practical criteria. In the first testl and II test, the implementation of teaching materials has met the specified criteria, which has reached the good category ($80 \leq k < 90$). This is supported by the results of Eka's (2018) research which shows that the development of teaching materials with a metacognition-based approach that is developed meets practical criteria.

b. Problem Solving Abilities

Based on the results of the analysis of the increase in students' mathematical problem-solving abilities in the firsGt test and the second test, it showed that the average student's mathematical problem solving ability in the pretest test I was 64.59 and increased in the posttest test I to 74.19. Then in the second test, the average result of the students' mathematical problem solving ability in the pretest test II was 66.25 and it increased again in the posttest test II of 82.66. Thus, there was an increase in the average score of

students' mathematical problem solving abilities by 9.6 in the first test and an increase of 16.41 in the second test. Meanwhile, the increase in the results of the posttest test I and test II was 8.47.

Then when viewed based on the calculation of N-Gain to see an increase in students' mathematical problem solving abilities in the first test and the second test, it has increased from 0.36 to 0.60, meaning that it is in the "Middle" category. This shows that students' mathematical problem-solving abilities using teaching materials developed based on the ICT-assisted metacognition approach have increased from test I to test II.

This is reinforced by the results of research by Rizqi, Asmin, and Fauzi (2017) which found that there was an increase in students' mathematical reasoning abilities through teaching materials based on the developed metacognition approach. Furthermore, research conducted by Fitriani, Hasratuddin and Syahputra (2014) provides results that by developing learning devices that meet the criteria for the effectiveness of a learning device it can improve students' mathematical communication skills. The results of these studies indicate that developing a teaching material based on the metacognition approach can improve high-level abilities in mathematics.

Thus, teaching materials with the ICT-assisted metacognition approach model can improve students' mathematical problem solving abilities.

c. *Self-Regulated*

In the first trial, there was indicator 1 (learning initiative), indicator 2 (Diagnosing learning needs), indicator 3 (Setting learning goals), indicator 4 (monitoring, managing and controlling learning progress), and indicator 8 (evaluating) in the category High learning independence, while indicator 5 (Seeing difficulties as a challenge), indicator 6 (Utilizing and finding relevant sources), indicator 7 (Evaluating) and indicator 9 (Self-Concept) are in the category of moderate learning independence.

For more details about the percentage average score of student learning independence for each indicator in the first trial, it can be seen in the following Figure 1.

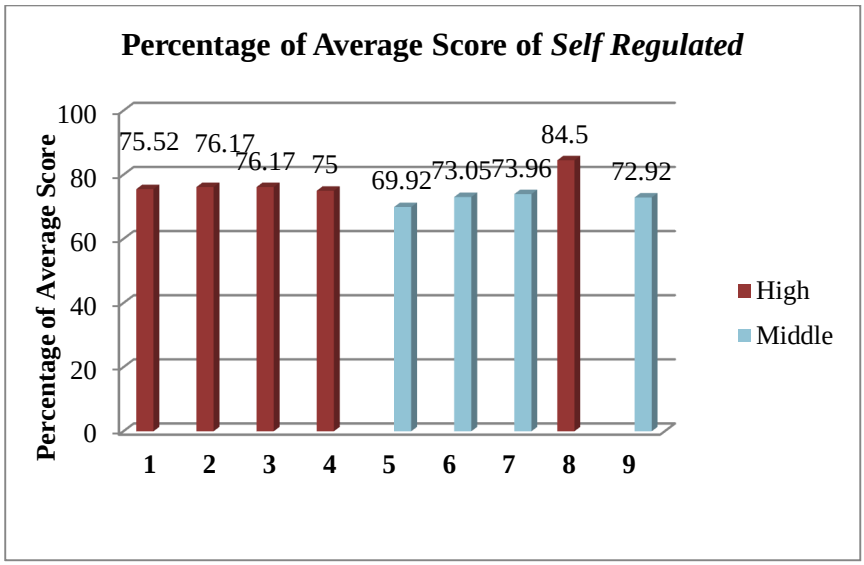

Figure 1. Percentage of Average Score of Learning Independence

From Figure 1, it can be seen that indicator 8 (evaluating) is the indicator with the highest percentage gain, namely 84.5%, while indicator 5 (seeing difficulties as a challenge) is the indicator with the lowest percentage gain, namely 66.92%.

In the second trial, all indicators were in the category of high learning independence. For more details about the percentage average score of student learning independence for each indicator in the second trial, it can be seen in Figure 2. below.

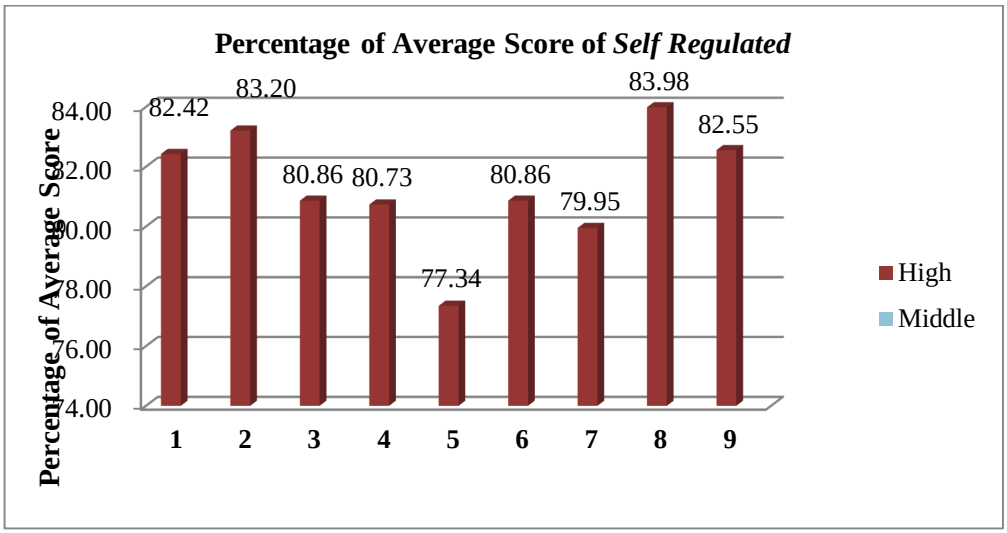

Figure 2. Percentage of Average Score of Learning Independence for Each Indicator Trial II

Based on Figure 2, it is found that indicator 8 (evaluating) is the indicator with the highest percentage gain, which is 83.98%, while indicator 5 (Viewing difficulties as a challenge) is the indicator with the lowest percentage gain, which is 77.34%. Then, if viewed based on the achievement of the independent learning category, there is only 1 category, namely the high category. Where all indicators are in the category of high learning independence.

Then based on questionnaires and interview results from several students, it is known that students tend to only accept material provided by the teacher without wanting to look for other reading sources because facilities in schools such as libraries also do not support students in the learning process. When they have free time, students usually spend their time going to other places instead of using their break time in the library to read.

The achievement of learning independence obtained from the results of this trial is in line with research conducted by Karlimah (2017) on elementary students who stated that solving math problems based on metacognitive strategies can form student learning independence. Likewise with Zimmerman (1989) which states that metacognition, motivation, and behavior affect students' independence in learning. Furthermore, Surya, Syahputra, and Juniati (2018) also prove that learning that involves active students in learning contributes positively to student learning independence. This can be seen from the percentage of student learning independence who are in the very high category reaching 13.64%, the high category reaching 72.72%, and the moderate category reaching 13.64%.

5. Conclusion

1. ICT-assisted mathematics-based teaching materials meet the valid criteria with an average value of the total validity of RPP of 4.81, student books of 4.83 and LKPD of 4.85, tests of students' mathematical problem solving abilities and self-regulated questionnaires have been valid category.
2. ICT-assisted mathematics-based teaching materials have met the practical criteria for use in learning in terms of: (1) the validator's assessment of the learning tools developed as a whole are good and can be used easily; (2) the subject teacher said that the learning tools used were easy to use; (3) students said that the learning tools used were easy to use and (4) the learning implementation using the developed learning tools was in the very good category.

ICT-assisted mathematics-based teaching materials in improving mathematical problem-solving abilities and self-regulated learning have been effectively used in learning, which includes: (1) classical learning completeness reaches 90.62% which has met the completeness criteria, namely ≥85% of students have achieved KKM; (2) the teacher's ability to manage learning is in a good category; and (3) the student's response to the components of learning equipment and learning activities is positive.

4. Improved students' mathematical problem-solving abilities using ICT-assisted cognitive-based teaching materials on social arithmetic material seen from the average student's mathematical problem-solving ability

on the pretest results of trial I was 64.59 and increased in posttest I trial to 74, 19. Then in the second trial, the average result of the students' mathematical problem solving ability in the pretest trial II was 66.25 and it increased again in the posttest trial II of 82.66. Furthermore, seen from the N-Gain in the first trial and the second trial, there was an increase from 0.36 to 0.50, meaning that it was in the medium category. In addition, the average of each indicator of students' mathematical problem solving abilities also increased from trial I to trial II.

5. Changes in self-regulated students by using teaching materials based on the metacognition approach developed and assisted by ICT can be seen from the average overall self-regulated questionnaire in trial I of 2.98 increasing in trial II to 3.25.

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