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SELF-REGULATED LEARNING MODEL WITH MIND MAP TO IMPROVE STUDENTS COGNITION AND METACOGNITION SKILLS IN SOLVING CHEMICAL PROBLEMS

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Abstract. The research has been conducted on the application of Self-Regulated Learning (SRL) model with mind map in solving chemical problem on Hydrolysis Salt material in class XI MIPA . This study aims to improve (1) implementation SRL model with mind map in classroom, (2) student activity, (3) learning outcomes of cognition, and (4) metacognition skills. The study used a classroom action research design consisting of two cycles with four learning meetings and two evaluation meetings. The subjects of this study were students of class XI MIPA 6 SMAN 7 Banjarmasin with 36 students. Instrument of research in the form of metacognition skill and cognition test instrument, observation sheet of teacher and student activity, and questionnaire of metacognition skill. Data were analyzed by using descriptive analysis of quantitative and qualitative. The results showed that there was an increase (1) teacher activity from good category to be very good, (2) student activity from active category become very active, (3) mastery of cognition learning result from 44,44% to 88,89%, and (4) metacognition skills of the category began to develop into a well-developed.

Keywords: Metacognition skills, cognition, model self-regulated learning, mind map

INTRODUCTION

Learning of salt hydrolysis materials are not only demand conceptual understanding but also algorithmic understanding. Both of them plays an important role in studying chemistry. Because, due to in-depth understanding of chemical facts, students are required to master not only the quantitative aspect, but also the qualitative concepts. Various studies showed that most students have been mastered algorithmic understanding, but have not been understood chemistry concepts. As instance, Zoller (2001) found that student who success in solving algorithmic problems by no means have a good conceptual understanding in chemistry.

Refer to the 21st century education, ways of thinking into four groups: thinking as creativity, critical thinking, problem solving, and metacognition (Greenstein, 2012); Griffin & Care, 2015). The problem solving process is student activity involving metacognition (Howard, 2004; Gama, 2004; Jacobse & Harskamp, 2012). If students involve metacognition in solving problems can also maximize their learning outcomes (Gama, 2004).

Metacognition skills refers to planning, monitoring, and evaluation skills (Cooper & Sandi-Urena, 2009; Herscovitz et al., 2012). Ridley et al. (1992) expression his opinion that metacognitive skills include taking conscious control of learning, planning and selecting strategies, monitoring the progress of learning, correcting errors, analyzing the effectiveness of learning strategies, and changing learning behaviors and strategies when necessary.

Metacognition is an important component of learning and self-regulation (Efklides, 2008, 2011), and has an important role in the problem solving process (Rickey & Stacy, 2000), because with metacognitive skills students are required to determine what plans they will do to solve problems, apply the things they have planned, to evaluate what things they are planning has been in accordance with what they applied (Schraw & Dennison, 1994).Metacognitive questions used to assist the students try metacognition skills in solving the problems (Mevarech, & Kramarski,1997; Mevarech & Fridkin, 2006).

In the opinion of some experts, metacognitive questions play an important role in making the students' learning process more efficient. For example, questions can help students to: (1) activate their pre-knowledge, (2) increase the students' understanding to the task, (3) improve their cognitive processes , (4) use of metacognitive skills, (5) improve and enhance metacognitive skills , and (6) help students to be aware of the problem that they can solve (Osman &. Hannafin, 1994; Mevarech, & Kramarski,1997; Mevarech & Fridkin, 2006; Kramarski & Zeichner, 2001; Conner, 2007, Kaberman &. Dori, 2009;Syahmani, Suyono, Supardi, 2017).

This metacognition skill requires students to solve a problem gradually, so the development of student metacognition skills means that students have experienced an increase in the way of thinking in each student so that it is in accordance with the definition of metacognition skills itself, which is a skill in thinking in order to develop strategies to solve problems (Ertmer & Newby, 1996).

One of the cognitive constructivist learning models related to metacognition skills is the Self-Regulated Learning (SRL) model. The structure of the self-regulated learning process is broken into three phases: 1) the forethought phase (task analysis, self-motivation beliefs), 2) the performance phase (self-control, self-observation), and 3) the self-reflection phase (self-judgment, self-reaction) (Zimmerman & Schunk, 2004; Zimmerman, 2008). Other expert opinions that are almost the same suggest that the SRL model consists of three phases, namely the planning, performance, and self-reflection phases (Moreno, 2010).

The aim of SRL is to facilitate life-long learning skills. SRL has been defined as the feelings and actions that indicate a tendency to achieve individuals' goals (Zimmerman & Schunk, 1989). SRL is an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behaviour (Pintrich, 2000). Students become more motivated to learn (Glynn, Aultman, & Owens, 2005), students become proficient in regulating their learning and improving their learning outcomes (Steffens, 2006), and lead to meaningful learning (Philip, 2005). Avozedo et al. (2010, 2012, 2013) and Pintrich (2000) suggest that SRL's advantages involve 4 processes, namely: cognitive, affective, metacognitive, and motivational (CAMM). In addition, an increase in learning outcomes indirectly can also increase student motivation, because by setting up self-learning, students will feel more comfortable. The application of the SRL learning model can provide opportunities for students to actively participate in the learning process and develop their metacognition skills that are very closely related to problem solving skills (Zahary, 2015).

Training in metacognition skills in learning can make students build their conceptual understanding of theories, facts, rules, descriptions, and chemical terminology and all information that forms the basis of constructive understanding in an algorithmic problem.

The application of the SRL model assisted by mind map is expected to improve students 'conceptual understanding, because with the mind map students are required to be able to find the core of the material to be studied based on students' own understanding. Mind maps can also increase student creativity, because the more branches they make, the more branches in their brain or in other words the more knowledge they have (Ayal et al., 2016)

METHOD

The study was conducted by using the classroom action research design developed by Stephen Kemmis and Robin McTaggart. The experiment was conducted in two cycles and each cycle consisted of four phases: planning (plan), execution (act), observation (observe), reflection (reflect) (Hopkins, 2011).

The action was given in the grade XI of MIPA 6 SMA Negeri 7 Banjarmasin in even semester with the number of research subjects as many as 36 people and on the material of Salt Hydrolysis. The research had been conducted since February to April 2017. The cycle I was held in 3 meetings and the cycle II in 3 meetings. The technique of collecting data used was by using test and non-test technique.

The test technique was done by using cognition and metacognition skill test instrument. The metacognition skill instrument used was in the form of problems and in the form of essay. The non-test technique was carried out by observing the implementation of the learning plan by the researcher's colleague and the researcher's field note, and metacognitive skill questionnaire with 20 statements adapted from Metacognitive Awareness Inventory (MAI) (Aprilia & Sugiarto, 2013).

The test instrument used in the research was firstly being validated by 5 panelists. Validation referred to the Content Validity Ratio (CVR) that was developed by Lawshe (Cohen, 2010) and each item of the instrument had a minimum score that is 0.99 (essential or valid).

Qualitative data analysis was used for analyzing the results of non-test data that had been collected. The approach in the qualitative data analysis was using the Interactive Model analysis technique developed by Miles & Huberman (1994), which are the display data, the reductions data and the conclusions.

The indicator of success in the implementation of the action was the students' metacognitive skills in solving the problem at least 61 as the minimum score and cognition learning outcome at least 75 as the minimum score.

The result of the metacognitive skill was determined by development category were shown in Table 1 below.

Table 1 Development category of metacognitive skills

Criteria	Category
0 – 20	Undeveloped
21 – 40	Still very risky
41 – 60	Starting to develop
61 – 80	Well-developed
81 – 100	Very well-developed

(Syahmani *et. al*, 2013)

The determination of student activity and mind map category is available in Table 2.

Tabel 2 Category student activity and mind map

Criteria	Category
1 – 20	very not good
$20 < x \leq 40$	not good
$40 < x \leq 60$	quite good
$60 < x \leq 80$	good
$80 < x \leq 100$	very good

(Ratumanan & Laurent, 2003)

RESULT AND DISCUSSION

This research was conducted in two cycles with the aim to improve the implementation of learning in order to get optimal results. Based on the data obtained through the learning process, an analysis is then carried out. The SRL model assisted by mind map was carried out in three stages, namely the planning, performance, and self-reflection stages. Learning activities in cycle 1 below.

(1) Planning phase. Students plan learning activities. The use of mind map in this phase in the form of apperception to provide initial knowledge to students and in line with the learning objectives given by the teacher.

(2) Performance phase. This phase is the implementation of planning that has been prepared before. Performance involves the process of thinking, writing, and speaking in solving problems and building knowledge. This phase is done by structuring the right learning environment, so students can choose the right learning environment and seek help in learning. When experiencing difficulties students can ask for help from other students or teachers. If there are problems that are not resolved, then a problem solving discussion will be held.

(3) Self-reflection phase. This phase is done by conducting an assessment of yourself. Self- assessment is the process of comparing the results of the performance that has been done with the learning objectives. Self-reflection or self-assessment is the most important part and is one of the advantages of SRL. Self-reflection must be held by students in the learning process

so as to achieve more optimal results. Based on the statement given by students, it appears that students have begun to be able to plan and find alternatives in solving problems and completing them completely. This shows that students have had initial knowledge through the mind map that they have made before.

Self-regulated learners are aware of their strengths and weaknesses, and can motivate themselves to engage in, and improve, their learning. At the heart of this is metacognition. Understanding what we mean is the first step in helping teachers to improve pupils' metacognition.

We approach any learning task about: (1) our own abilities (cognition) and attitudes, (2) what strategies are effective and available, (3) (knowledge of strategies); and (3) task activity (knowledge of the task).

When undertaking a learning task, we start with this knowledge, then apply and adapt it. This is metacognition skills. It is about planning how to undertake a task, working on it while monitoring the strategy to check progress, then evaluating the overall success.

This is not a one-off process of discrete steps, but an ongoing cycle. As you progress through the task applying your cognition and metacognition skills. The cycle of plan, monitor, evaluate are recurrent themes throughout this guidance. Teachers should consider these when setting learning tasks and supporting pupils to complete them. In an expert learner, these processes are unconscious and automatic. In novice learners, however, it can be valuable to make them explicit.

The implementation of the SRL - mind map model has been applied by teachers in the class-room to experience an increase from cycle I to cycle II in learning. This increase can be seen in Table 3.

Tabel 3 Learning Implementation

Rated aspect	Cycle I		Cycle II	
	$\overline{P1}$	$\overline{P2}$	$\overline{P1}$	$\overline{P2}$
Preliminary	3.00	3.00	4.17	4.28
Core activities				
Phase 1 Planning	2.58	2.92	4.08	4.08
Phase 2 Performance	2.58	2.92	4.33	4.50
Phase 3 Self-reflection	2.33	3.00	4.00	4.00
Closing Activity	3.00	3.25	3.92	4.00
Time management	3.00	3.33	4.33	4.33
Class situation	3.00	3.33	4.00	4.00
The average observer's overall rating	2.69	3.17	4.13	4.22
Average percentage	59.56%	63.37%	82.67%	84.36%
Average percentage of cycle	61.67%		83.51%	
Category	good		very good	

$\overline{P}$ = the average observers assessment for each meeting

Based on Table 3, information was obtained that the results of observations on the implementation of the learning plan (RPP) in classroom were categorized as good with an average percentage assessment of three observers was 61.67% in learning cycle I to 83.51% in learning cycle II. The increase in the implementation of the SRL model is due to the teacher being able to become a better facilitator in learning cycle I to cycle II. The teacher has also been able to give freedom to students to solve problems faced by students in their own way. The stages of the SRL model assisted by mind map have been able to be run optimally by the teacher, so that this affects student activities in learning.

The increase in the implementation of the SRL model also affects the increase in student activity in learning, because students have been able to follow the learning using the SRL mind map model well. This is in accordance with aspects of the SRL model that can increase student activity in metacognition, behavior, and motivation (Zahary, 2015). In addition, students have felt happy in learning because students are given the freedom to regulate their own learning processes, such as searching for problem solving in their own way, applying the methods he has determined, and reflecting learning in accordance with what has been learned (Moreno, 2010). Increasing student activity from cycle I to cycle II can be seen in Figure 1.

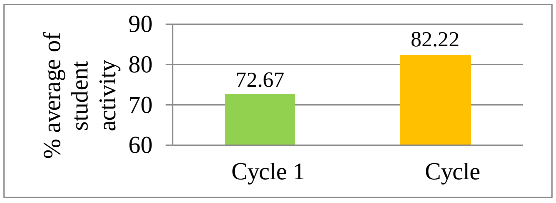

Figure 1 Students activity

In learning using the SRL model assisted by mind map, in addition to the increase in teacher activity there was also an increase in students' metacognition skills. This is in accordance with the opinion of Zahary (2015) that the application of the SRL model in learning will make students active by metacognition, behavior, and motivation. There are three aspects of metacognition skills, namely planning, monitoring, and evaluation skills (Schraw & Dennison, 1994).

The assessment of students' metacognition skills in this study was carried out through tests and questionnaires containing 20 statements of the Metacognition Awareness Inventory (MAI) (Aprilia & Sugiarto, 2013). The research results showed that there was an increase in the students' metacognitive skills in solving problems by using *SRL-mind map*. In the cycle I, the average metacognitive skills of the students in solving the problems was 52.51 and increased to 72.76 in cycle II. The Results of this improvement were shown in Table 4 below.

Table 4 Results of tests on students' metacognition

Indicator	Metacognitive Questions	Percentage	
		Cycle **1**	Cycle **2**
Planning	a	72.23	97.92
	b	73.13	95.13
	c	60.63	88.89
	Average	68.67	93.98
Monitoring	d	41.67	65.28

	e	47.23	65.28
	Average	44.44	65.28
Evaluating	f	43.52	59,03
Average Total		52.51	72.76
Category		Starting to develop	Well-developed

Remaks:

a. What is the problem about?
b. What are the data?
c. What strategy can be used in order to solve the problem?
d. Why does the strategy become the most appropriate strategy for solving the problem?
e. How can your planning be applied?
f. Is you strategy applied is appropriate to the planning? Why is it appropriate?

Based on Table 3, Model SRL encourages students to become involved in regulatory learning by using metacognitive questioning. The metacognitive questioning encourages students to be actively engaged in self-regulation of their learning through the use of four kinds of questions: comprehension, connection, strategy, and reflection. Comprehension questions are designed to help students understand the information of the task or problem-solving (e.g., "What is the problem/task?", "What is the meaning of?"). Connection questions are aimed at prompting students to understand deeper-level relational structures of the task by articulating thoughts and explicit explanations (e.g., "What are the data?", "How do you justify your conclusion?"). Strategy questions encourage students to plan and to select the appropriate strategy (e.g., "What is the strategy", "Why is this the appropriate strategy?"). Reflection questions play an important role in helping students monitor and evaluate their problem-solving processes. Reflection questions encourage students to consider various perspectives and values regarding their selected solutions (e.g., "Is you strategy applied is appropriate to the planning? Why is it appropriate?').

The results of cycle I showed that the students' ability in solving the problems had score below the achievement indicator criteria that established in this study. The average classes of students' metacognition skills to solve the problems ware only 52.51, which the students were not yet to complete the achievement. In cycle II, the students' metacognition skills in solving the problems were only 72.76. The results of cycle II were slightly higher than the established achievement indicator, despite it had been increased. It happened because the metacognitive questions presented in the study. The metacognitive questions are one of the criteria of students' metacognitive to solve the problems. The students' metacognitive to solve the problems is an evident of their ability to solve non-routine problems. These problems are related to McIntosh & Jarrett's (2000) statement that the students will have problem in solving non-routine using metacognitive questions. However, the problem in solving non-routine problems would be a matter of disregard, when it is viewed from the benefits of solving non-routine problems. That benefits are the ability of the students in thinking and reflecting the results of their mind. Both of them are the goals in each learning process.

The cognitive and metacognitive aspects need to be explored more deeply as an integrative part of the problem solving ability. In terms of cognitive aspects, the results of cycle I was below the achievement indicators. Meanwhile, the students' metacognitive in cycle I was in starting to develop. It means that students' metacognition skills are not fully formed and there is still doubt about the metacognition skills. This doubt is caused by metacognitive skills possessed by the students are only in the form of process modeling to the teacher's explanation regarding the meta-cognitive. The students only copy the teacher's answer to the teacher's example of problem solving based on the metacognitive questions.

The development of metacognitive students after the implementation of the action in cycle II was increased compared to cycle I. The metacognition skills was started to develop become well-developed, which means the students begin to be able to control the knowledge that they have, and start to realize and know the knowledge that they have.The increase of metacognitive development caused the increase of cognitive learning outcomes is in line with the findings of Mevarech and Kramarski (1997) research that metacognitive previously combined with cooperative learning has a positive impact on the students cognitive learning outcomes and problem-solving skills in general (Mevarech & Fridkin, 2006). The increase of metacognitive development can occur because any metacognitive skills can be improved by the exercise (Özsoy & Ataman, 2009). The regularly and continuously exercise by a learning method using problem solving to improve students' cognition and metacognition skills. These results are consistent with Koit & Kotze (2009) which stated that the students who have good metacognition skills will be a better solver. This condition is caused by students who have good metacognition will have the ability in the knowledge of cognition and the cognition control (Mevarech & Fridkin, 2006).

The cognitive and metacognitive is a unity and an integrated part of the problemsolving process. The cognition is a way to acquire and process the information, save the information and recall it in learning or problem-solving activities. In addition, metacognition is a way to control all of these things. The improvement of metacognitive skills affect the cognitive ability of the students. It can be seen from the results of cycle II which showed that cognitive results increased with the increasing of metacognitive skills. The connection between metacognitive and the improvement of cognitive learning outcomes are confirmed by Gartman and Freiberg (1993) and of Gama (2004) that the metacognition can optimize the students' learning outcomes.

The results of the students 'metacognitive questionnaire showed that students' metacognitive skills in the category had developed well. Figure 2 shows that the development of students 'metacognition skills increased from cycle I to cycle II based on students' self-assessment. This result is caused by students being able to develop metacognition skills after the learning process. Metacognition skills can be formed with habits carried out and trained continuously. The role of the teacher gives direction to students and the application of learning models is very large for improving metacognition skills. This is in accordance with the opinion of Budiningsih (2012) that teaching strategies that require student activity and participation are optimally able to change student behavior more effectively and efficiently so as to increase understanding and reinforcement of memories and change attitudes and learning outcomes more durable.

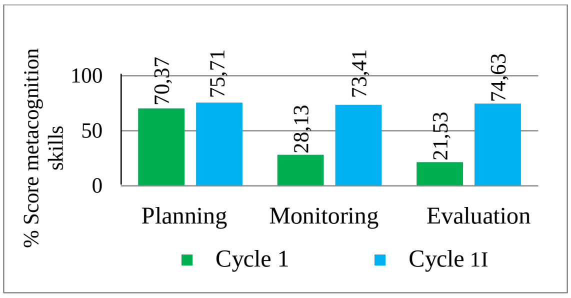

Figure 2 Results of questioner on students' metacognition skills

This shows that there has been an increase in students' metacognition skills. Students can organize their own learning process in problem solving and have been able to develop their learning concepts and develop their own skills (Iskandar, 2014). Based on research by Aprilia & Sugiarto (2013), with good metacognition skills, it shows that students have been able to think in overcoming their own problems because they often spend themselves learning from mistakes.

High metacognition skills will also affect learning outcomes cognitively (Iskandar, 2014), because students have been able to organize their thinking well. The increase in student completeness (≥ 75) from cycle I to cycle II is shown in Table 5.

Table 5 Student Completeness of Cognitive

Cycle	≤ 75	≥ 75
I	44,46%	55,56%
II	27,78%	72,22%

Based on Table 4 shows that there has been an increase in the completeness of the cognitive learning outcomes of students using this mind map-assisted SRL model. This increase can occur because students have been able to manage their own learning methods and have known effective ways of learning (Fasikhah & Fatimah, 2013). Students who use metacognition are more likely to (a) develop conceptual understanding (Herscovitz et al. 2012), (b) go through a process of knowledge construction and meaningful understanding (Anderson and Nashon 2007; Nielsen et al. 2009), (c) reflection on the learning process and reduction of poor learning strategies (e.g., memorization) benefited students' standardized achievements (Thomas and McRobbie, 2001).

The role of the mind map in this study is to help the role of the SRL model in learning which is to increase students' independence in managing their learning, besides that students can also improve their mastery of concepts and creativity (Adhitama, Parmin, & Sudarmin, 2015). Making mind maps can also make students more easily understand learning material (Ayal, Kusuma, Subandar, & Dahlan, 2016). The increase in mind map results from cycle I to cycle II is shown in Figure 4.

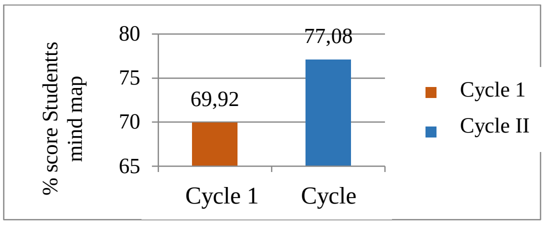

Figure 3 Results of students' mind map

Based on the results obtained, it shows that students' metacognition skills increase from cycle I to cycle II, it does not mean that the results of mind map also increase from cycle I to cycle II. The mind map made by students depends on their creativity and also the fun and motivation of students in learning using the SRL model assisted by mind map (Mulyadi, Basuki, & Rahardjo, 2016). Therefore, it has become the teacher's job so that students feel happy in learning.

Mind map is an ideal technique to train creative thinking skills. This is because mind map utilizes all the skills commonly associated with thinking, especially imagination, linking ideas, and flexibility. Based on these assumptions, learning using mind map is expected to map the students' minds and provoke their thinking in all directions and bring brilliant and creative ideas (Buzan, 2012; Davis *et al.*, 2000; Al-Jarf, 2009; Weinstein, 2014). Long & Carlson (2011) suggested that the use of mind mapping helped students make connections between previous material information and the material. Wheeldon (2011) also revealed that respondents who used mind mapping could remember, organize, and frame the reflection of their past experience Mind map makes students happy and motivated in SRL model learning (Mulyadi, Basuki, & Rahardjo, 2016).

The combination of *SRL* and mind map in learning science contributed highly to improving students cognitive metacognitive skills. This was because integrating a mind map at each stage of *SRL* would facilitate the students in managing and understanding information effectively and systematically. The ability to manage and understand information is key to achieving the cognitive and metacognitive skills.

CONCLUSION

Based on the research conducted, it can be concluded that if there is an increase (1) the teacher's activity from the category is good enough in the first cycle to be very good, (2) the activity of students from the active category becomes very active, (3) the completeness of students' cognitive learning outcomes exceeds 75% cycle II, (4) metacognition skills from the category began to develop into well-developed.

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