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## Improving Students Metacognitive Abilities Through Mind Mapping with Problem based Learning Learning Models on the Concept of Environmental Pollution at SMAN 7 Pekanbaru

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### ABSTRACT

The K13 Curriculum requires students thinking skills, especially in the regulation of cognition which consists of planning, information management strategies, monitoring, examination of actions, and evaluation. This study aims to look at the metacognitive abilities of class X students of SMAN 7 Pekanbaru on the concept of environmental pollution through mind mapping with problem based learning models. This type of research was a quasi experiment using two classes, one class as an experimental class and one class as a control class. The experimental class used mind mapping models of problem based learning and the control class used conventional learning. The research design used a pretest-posttest control group design. Data collection techniques used questionnaires metacognitive abilities and description test questions. The analysis technique used the Anova test analysis. The results of the pretest and posttest showed a significant increase in students metacognitive abilities through mind mapping with the problem based learning model of the concept of environmental pollution at SMAN 7 Pekanbaru with a significance value of 0,000. Sig. (0,000) < then H0 is rejected, so it can be concluded that the metacognitive abilities of students are increased through mind mapping with problem based learning models on the concept of environmental pollution.

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## 1. Introduction

In accordance with the demands of the 2013 curriculum, biology learning should be student-centered (Student Center Learning) no longer teacher-centered. Learning biology in schools should be able to prepare students in solving problems faced in real life by using the biological concepts they learn, be able to

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make decisions appropriately using scientific concepts, be able to anticipate the negative impacts of scientific and technological progress and be able to think anticipatively into the future front (Suastra, 2013).

Students are required to play an active role in learning activities, develop concepts and interpret the learning outcomes they receive by giving problems. The independence of students in solving problems, being able to think and manage the work done in obtaining a solution is related to students' metacognitive. Success in problem solving is very closely related to students' thought processes at the metacognitive level. In accordance with the opinion of Suherman, (2001) states that with metacognitive abilities, students can have high ability in solving problems because every step that is done can awaken his thought process, so he can solve problems optimally.

One learning model that provides many opportunities for students to develop students' metacognitive abilities is problem-based learning (PBL). PBL model learning is done by providing stimuli in the form of problems which are then carried out problem solving by students which are expected to improve students' metacognitive abilities in the achievement of biology learning material. Researchers chose environmental pollution material which is one of the ten threats officially warned by the High Level Threat Panel of the United Nations about environmental damage.

The concept of environmental pollution falls into the category of PISA and TIMSS questions and is in accordance with 3.10 basic competencies learned in high school, namely analyzing data on environmental changes and the impact of these changes on life. By giving environmental problems in Riau Province, it is expected that students' metacognitive abilities will improve in an effort to solve existing problems, think of the problems presented, then make appropriate decisions and solutions to what is done. So, metacognitive ability is very important to have students, because it relates to problem solving and student independence in learning.

Provision of problems can be applied with a problem based learning model or problem based learning. PBL models encourage students to more actively explore their own knowledge and work together to solve problems presented by the teacher. To overcome the difficulties in processing and organizing extensive information or subject matter, it can be assisted with learning media, one of which is Mind Mapping as a student learning media (Hilman, 2014). Mind map in this study is used as a summary to build concepts of knowledge and increase student learning independence that has an impact on students metacognitive abilities.

Pre researching the results of observations made by researchers through interviews with teachers at SMAN 7 Pekanbaru, the teacher has not implemented a learning model that is able to improve students metacognitive abilities. This is also in line with the results of interviews with students, it appears that students efforts are not optimal during the learning process, immature learning planning and the ability of students to think about their weaknesses in learning and find the

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right solution, is still lacking. In accordance with the opinion of Paidi, (2008) that learning biology is seen as having the potential to empower students' metacognitive abilities, in their daily lives teachers rely solely on teaching methods that strengthen aspects of student memory.

By using mind mapping with the problem based learning model, students are expected to be able to express their ideas and ideas to solve the problem under study. In addition, students' metacognitive abilities can be assessed through mind mapping with student learning experiences (metacognitive regulation) in the form of planning, monitoring, and evaluation. This is in accordance with research conducted by Farrand et al., (2002) found that mind mapping not only helps students in learning, but encourages deeper levels of learning, especially when paired with problem-based learning models.

Based on the background above, the problem formulation in this study is how to increase metacognitive abilities through mind mapping with problem based learning models on the concept of environmental pollution. Students' metacognitive abilities are one of the thinking abilities that students need to master for their cognitive use in solving problems, especially in learning biology. The metacognitive awareness instrument was first developed by Schraw et al., (1994) under the name MAI (A Metacognitive Awareness Inventory), developing a Likert attitude scale measuring cognitive regulation with the Metacognitive Awareness Inventory (MAI). This scale is to confirm the existence of five factors that are related to the regulation of cognition.

The relationship between learning problem based learning with students' metacognitive abilities explained by Suherman, (2001) students who have high metacognitive abilities in solving problems have a way in every step that is done and can awaken their thought processes, so he can solve problems optimally. A person's ability to determine a plan or strategy in making and completing mind mapping shows the better the metacognitive abilities they have. This study aims to determine students' metacognitive abilities through mind mapping with problem based learning models.

## **2. Methodology**

This type of research was a quasi-experimental type. This study used two classes, one class as an experimental class and one class as a control class. The research design used a pretest-posttest control group design. According to Sugiyono, (2014) the research design consisted of two groups chosen randomly. The ability of both groups was measured by pretest before treatment and posttest after treatment. The research site of SMAN 7 Pekanbaru was conducted in the even semester from April to June 2019.

The research population used all students of Pekanbaru 7 Senior High School in 2018/2019 Academic Year. The research sample consisted of 71 students in each class consisting of 35 MIPA 4 students and 35 students in MIPA 2. The sampling

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technique was total sampling. The parameters used in this study are the students metacognitive abilities with data collection techniques using a questionnaire, and a description test in the form of a pretest and posttest. The categorization of students metacognitive awareness questionnaire scores was based on the modification of Paidi (2008) as in Table 1.

Table 1. Categorization score scores of students' metacognitive awareness questionnaires

Interval (%)	Value	Category
85-100	A	Very good
71-84	B	Good
57-70	C	Enough
<57	D	Very less

Analysis of metacognitive abilities through mind mapping with Problem Based Learning (PBL) learning models was done by testing One Way ANOVA (Analysis of Variance) or Anova one factor.

### 3. Results and Discussion

The metacognitive abilities of students to be measured. There are 5 aspects of cognitive regulation, namely (1) planning, (2) information management strategies, (3) monitoring, (4) examination of actions, and (5) evaluation. Metacognitive abilities were measured with a Metacognitive Awareness Inventory (MAI) questionnaire and a description item. Prior to the pretest, the questions were tested on grade X students to measure reliability, validity, different power, and level of difficulty using SPSS.

Measuring metacognitive abilities were conducting pretest before the treatment was carried out. After 4 meetings through mind mapping with problem based learning models in the experimental class and conventional models in the control class, the posttest was done to see the increase in students metacognitive abilities on the concept of environmental pollution through questionnaires and question details. The results of the overall data assessment of the metacognitive indicators of students before treatment (Pretest) and after treatment (Posttest) between the experimental class and the control class are presented in Table 2.

Table 2. Scoring metacognitive awareness questionnaire scores

Indicators of Metacognitive Awareness Questionnaire	Experiment Class (X MIPA 4)		Class Control (X MIPA 2)	
	Pretes%	Postes %	Pretes %	Postes%
	Planning	68	87	62
Information management strategy	66	87	61	73
Monitoring	68	89	63	76
Action check	70	92	63	78
Evaluation	66	85	62	73
Average	68	87	62	75
Category	Enough	Veru Good	Enough	Good

### ***Planning Indicators***

The experimental class has the higher value, because it involves students to find the right alternative answers, provide opportunities for students to contribute ideas in problem solving, train students to work together in discussing and solving a problem. In the control class the student has no alternative in how he learns. This resulted in students awareness of achieving learning goals is still low. Students are able to do planning when making mind mapping, students are able to predict, check material and determine the things they will include in the mind map, including keywords, links in concepts, strategies for sorting environmental pollution concepts, and allocating effective time in completing assignments. In line with Tanriseven's opinion, (2014) explained that the use of mind maps as a planning tool allows students to have a better understanding of the use of mind maps for planning purposes, goal setting, exam preparation, and group activities so that the learning conducted will become more lively, varied, and accustom students to solve problems by maximizing the power of thought.

### ***Information Management Strategy Indicators***

In this incator, the experimental class has also the highest value, because students read information that has been provided in the LKPD related problems in Riau Province, by linking information provided by focusing on one problem that will be solved using examples and data to look for sources of pollution, pollutants, mechanisms pollution, impact on the environment and humans and efforts to prevent environmental pollution. In the experimental class students find more information, to build knowledge concepts and responses during completing assignments or problems that can practice metacognitive compared to control classes that only get information from the teacher. In line with the opinion of Paidi, (2008) the skills or strategies for managing information can be used to process information more coefesien, combine, conclude, focus or determine priorities.

### ***Monitoring Indicators***

The monitoring indicator, the experimental class has also the highest value, because students are given the opportunity to argue for answers to questions based on their thinking and actively ask questions and can answer problems with several solutions. The problem presented by researchers is in the form of ill-structured solutions of more than one (Tan, 2009). When students complete LKPD well, monitoring the results of problem solving that makes sense and is easy to understand. Mind mapping presentations can also help teachers monitor student understanding. The teacher monitors the course of the discussion and directs every question answer that is less relevant than the discussion activity. In accordance with the opinion of Flavell (in Cooper, 2004) that students who monitor or monitor cognitive processes will get better cognitive decisions than students who do not do it and need to be done by each student to monitor learning progress. In the control class students feel that memorizing subject matter is more supportive of their learning outcomes than monitoring the learning process.

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### ***Debugging Strategies***

In the experimental class, the students have the highest value for this item. It is because students are able to correct classmates mistakes by exchanging ideas and asking teachers to understand concepts. This is in line with the opinion of Paidi, (2008) that debugging strategies are steps taken to correct misunderstanding or acquisition. In the experimental class students were able to solve the problem by finding a misunderstanding in answering the problem by reading or re-examining the problem while the control class did not pay close attention to the problem because there was no group discussion in the learning process.

### ***Evaluation Indicators***

In the experimental class, it has the highest value, because in working on assignments students do not just think how to complete the task, but always evaluate themselves with the belief that the given task or problem has been solved properly and correctly. Students continue to strive to be able to complete the task very well together through group discussions and independently. Seen at the presentation, the presenter group reads the results of the mind mapping that has been made, while the other groups evaluate and give suggestions from the mind mapping results. Active interaction occurs in group discussions to make a mind mapping summary.

In accordance with the opinion of Lai et al., (2011) evaluation as an activity of assessing the periodic and regulatory processes of one's learning as well as reforming or revising an objective achieved. Students who have not been able to do reflection activities means these students do not have good metacognitive skills. With mind mapping, students can know the extent of their understanding of the material, so students can find out the meaning of the learning process. In accordance with research Ulfa et al., (2015) stated that mind mapping summaries can help students to develop metacognitive awareness.

With the application of the PBL learning model inviting students to solve problems that occur in Riau and surrounding provinces. With the existence of metacognitive abilities can help students make the right decisions, careful, systematic, logical, and consider various angles and can make students think about work planning to problem solving (Patonah, 2014). Students know how well success in problem solving is because students re-examine concepts or problems in LKPD by exchanging ideas to be able to summarize material in the form of mind mapping. At the beginning of the meeting students were still shy about asking both friends and teachers and the next meeting students were able to discuss well with their friends. By discussing and asking questions, students can correct misconceptions about concepts.

Achievement of student learning outcomes is not only influenced by the level of teacher knowledge of the subject matter to be taught, but is determined by the learning model and awareness of students themselves during the learning process takes place. The application of a good learning model can help students

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understand the lesson well too (Slameto, 2010). In line with the research of Hadi et al., (2009) shows that students who are taught using the PBL model have better metacognitive skills than students who are taught with conventional models.

Learning control class is still ongoing with the teacher providing information to students through the lecture method followed by regular discussion and question and answer. Though metacognitive abilities do not appear by themselves according to research Merina, (2019). One systematic effort is needed, one of them through the PBL model. In accordance with the opinion of Goodnough et al, (2003) states that PBL can increase student awareness in self-regulation (metacognitive).

In this study, mind mapping was assessed in groups to determine the participation of all group members. Each group has been able to make the broad material more concise and be able to explain the overall material learned in a concise language, use pictures and colors to make it more interesting, and integrate information more effectively and fun. This is relevant to the opinion of Wibowo, (2008), stating how the proper arrangement of notes and pictures can affect how information is remembered and constructed effectively effectively. In making mind mapping students are invited to optimize the work of both brains optimally according to the opinion of Buzan, (2006). The use of mind mapping has been done well even though there are still some students who still ask how to make mind mapping well. This can be seen from the results of the mind mapping assessment presented in Table 3.

Table 3. The results of the mind mapping assessment on the concept of environmental pollution class X MIPA 4 in groups in SMAN 7 Pekanbaru

Group	Meeting I	Meeting II	Meeting III
1	70	80	85
2	60	75	80
3	65	80	85
4	70	80	85
5	70	85	90
6	70	80	85
7	75	85	90
The highest score	75	85	90
Lowest value	60	75	80
Average	69	81	86
Category	Less	Enough	Good

Based on table 3, the first meeting of air pollution materials in making mind mapping summaries obtained an average of 69 categories that were still lacking. Seen from completing assignments, students already understand the problems that arise from the phenomenon of forest fires that occur in their environment and are able to provide solutions with strategies and action plans by reducing excessive forest fires, checking air quality status, and greening in urban areas. When making

mind mapping, students are not accustomed to connecting each concept with the core branches, images and colors. Seen from the summary concept words made by students are more directed into making concept maps.

The second meeting of water pollution materials, students in making a mind mapping summary obtained an average of 81 categories enough. Students already understand the problems that arise from four polluted rivers in Riau Province and are able to provide solutions with strategies and action planning that is not throwing both organic and inorganic waste into the river, conducting waste treatment before dumping waste into the river, recycling organic waste as compost or fodder so as not to be wasted as waste in the river, and carry out regular monitoring of factories and households that are around the river. When making mind mapping, students have become accustomed to being seen when students can relate each concept to the core branches, images and colors quite well.

The third meeting of soil pollution material, students in making a mind mapping summary obtained an average of 86 good categories. Students already understand the problems that arise from the phenomenon of the heavy metal content of the PETI Kuantan River and are able to provide solutions with strategies and action planning that is to clean heavy metals and reduce levels of heavy metals in the soil so that pollutants are reduced. When making mind mapping, students are used to being seen when students can relate each concept to the core branches, images, and colors well.

In the mind mapping summary students are able to discuss by exchanging ideas in the learning process so that students find their own concepts in groups. Mind mapping can change students' initial knowledge in accordance with concepts that are believed to be true. The summary column made blank can train students to understand the concepts they have by using students' own language and words. In accordance with the opinion of Firdaus, (2010) with mind mapping students are able to reconstruct the information that has been obtained. To measure students' abilities in analyzing and evaluating problems, additional data is needed for researchers in the form of a description test about the concept of environmental pollution. Data on the results of cognitive assessment of students can be seen in Table 4.

Table 4. Students cognitive assessment based on metacognitive description tests

Interval	MIPA Experiment Class X Grade 4		Value of Control Class X MIPA 2	
	Pre-test (%)	Post-test(%)	Pre-test(%)	Post-test(%)
91-100 (A)	-	1 (3)	-	-
83-90 (B)	-	24 (68)	-	4 (11)
75-82 (C)	-	9 (26)	-	11 (31)
<75 (K)	35 (100)	1 (3)	36 (100)	21 (58)
Total students	35	35	36	36
Average	46,86	83,86	38,68	72,78
Category	Not complete yet	Complete	Not complete yet	Not complete yet



Based on table 4 the results of the pretest and posttest scores of students with the average experimental class are higher than the average control class. In the experimental class, there was a very good category of 1 person, a good category of 24 people and quite a category of 9 people with a total of 34 students completing the KKM. Through the PBL model students discover concepts from independent learning experiences that make students always remember concepts for a long time according to research by Nur et al., (2020).

Environmental pollution material has problems that are often faced by students in daily life. Students are faced with environmental problems that require high-level thinking in solving them. The problem presented by researchers is in the form of ill-structured solutions of more than one (Tan, 2009). Students have been able to complete LKPD well, with various alternative solutions that make sense and are easy to understand. In accordance with the opinion of Marshall, (2003) practicing the students' metacognitive abilities can be done by giving difficult questions that allow students to provide a variety of alternative correct answers.

The experimental class uses a problem based learning model, encourages students to actively seek knowledge to identify and solve existing problems in LKPD, encourage students to work together with one another in groups to jointly solve the problems faced so that in answering student questions more able to answer or solve these problems according to the research of Lufri et al., (2020). It can be seen from the average value of the posttest in the experimental class of 83.86 complete categories and the control class posttest average of 72.78 unfinished categories.

Finding information, building knowledge and writing down what is thought and responses that arise during completing assignments or problems turns out to be very helpful to students in solving problems and training students in summarizing in the form of mind mapping. Strengthened by research Ulfa et al., (2015) states that metacognitive abilities increase after mind mapping is applied. This is indicated by an increase in the percentage of students' posttest scores. In accordance with research conducted by Bahri, (2010) said that students who have high metacognitive awareness will also have a good impact on cognitive learning outcomes.

From the prerequisite test, the metacognitive ability measurement data has met parametric requirements, namely the data is normally distributed and the data group variables are homogeneous, so that the data can be continued with the parametric hypothesis test using Analysis of Variance (ANOVA). Based on the results of the Analysis of Variance (ANOVA) statistical test, it showed that the significance value was 0,000, it can be seen that  $H_0$  was rejected, meaning that there was an increase in students' metacognitive abilities through mind mapping with problem based learning learning models on the concept of environmental pollution. Seen from the way of thinking of students in solving problems in LKPD and the questions given by the teacher and can understand the extent of success that has been achieved in learning. When understanding problems, students are able to show how to learn, and how to monitor their own learning, so students

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become more active and independent. This is in line with the opinion of Petters, (2000) explains that metacognitive enables students to develop into independent learners, because it encourages students to be regulators of themselves and become assessors of their own thoughts and learning.

According to the research of Chintani et al., (2018) concluded that there was an effect of the problem based learning model with mind mapping on metacognitive knowledge with a tcount greater than ttab ( $40.68 > 2.039$ ). Sudiarta, (2006) argues that metacognitive activities have the potential to produce students who have high-level thinking competencies, which can improve student learning outcomes. This is because students are able to complete their learning tasks well through the ability to plan, organize themselves, and evaluate the learning process.

#### 4. Conclusion

The mind mapping in the problem based learning model of the concept of environmental pollution has an effect on the metacognitive abilities of class X students of SMAN 7 Pekanbaru. The effect can be seen with an average value of an overall indicator, which is all the indicator including in the excellent category. The best metacognitive indicator of students is at the examination of measures with very good category.

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