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PBL Model Learning Innovation with MindMaple Assisted FILA Chart Design on Metacognitive Skills

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ABSTRACT

This study aims to determine the effect of applying the Problem Based Learning (PBL) model with the FILA chart design with the aid of MindMaple on the metacognitive skills of class XI high school students on the excretory system material. This research was conducted at SMA Negeri 1 Palembang. The research method used is Quasi Experimental Design with the research design of Nonequivalent Control Group Design. Determination of the research sample using the Simple Random Sampling technique so that class XI IPA 6 was selected as the control class, XI IPA 7 as the experimental class, and XI IPA 8 as the placebo class with a total of 36 students in each class. Metacognitive skills are measured through a pre-test and a post-test with the instrument 3 essay questions with cognitive levels C4 to C6 which has been tested for validity and reliability. Data were analyzed using SPSS 25 program, hypothesis testing using ANCOVA test. The results of the ANCOVA test analysis showed that the application of the Problem Based Learning (PBL) model with the FILA chart design assisted by Mind Maple had a significant effect on the metacognitive skills of students at SMA Negeri 1 Palembang. Next The average results of the metacognitive skills final test scores sequentially show that the application of the PBL model with the FILA chart design with the aid of MindMaple is better than the application of the conventional learning model with the FILA chart design with the aid of MindMaple and conventional classes in improving students' metacognitive skills

Keywords: Problem Based Learning (PBL), FILA chart, MindMaple, Metacognitive Skills.

Introduction

Biology learning is the transfer of a collection of knowledge from learning resources in the natural environment and facilitated by the teacher. Biology learning is expected to be able to provide skills to students to study a biological object, facts, and build concepts (Santosa, 2018). The difficulty in learning biology is because there are concepts that are abstract, complex, and use concepts that are based on memorization (Cimer, 2012). Even though learning biology requires thinking high levels such as HOTS and metacognitive (Madang, et al., 2019). Learning materials that are abstract, complex and tend to memorize include excretory system material.

The excretory system material is abstract, the processes that occur in the excretory organs where the results of the process are very closely related to daily life, and the excretory system material is considered difficult because there is a lot of theoretical and conceptual material that requires good understanding and knowledge (Susanto, 2014). In line with the statement of Sapitri, et al. (2015); Widiastuti, et al. (2015) the excretory system material discusses many physiological processes that cannot be seen directly by students and terms that are difficult to understand, so that the knowledge gained by students is not contextually connected.

Difficulties in the excretory system material will affect the learning outcomes obtained by students. Based on research Rahmayani, et al. (2017) an analysis of student learning outcomes at SMA Negeri 16 Medan shows that the level of mastery of students on the human excretory system material is still far from complete (KKM), the number of students who answered incorrectly from each of the existing indicators reached up to 98.75% which means very tall. Based on research Amini, et al. (2018). Students at SMA Negeri 1 Karang Baru who have completed achieving the KKM on the excretory system material are 23% and the rest who are not complete are 77%. In the cognitive aspect, the percentage of students with a high level of difficulty is (C3) 39.61%, and a very high level of difficulty, namely (C4) 46.5%, (C5) 46%, and (C6) 47.37% as well as material indicators of 44.42%. From the research above, it can be concluded that the difficulty of the excretory material affects the learning outcomes of students. Another factor that causes low learning outcomes also causes a lack of thinking skills, namely metacognitive skills. In line with Warouw (2010), one of the causes of the low learning outcomes of students' biology is due to the fact that students' thinking skills have not been empowered, including metacognitive skills in the learning process.

Metacognitive skills are skills to think about how to learn (Flavell, 1979). Applying metacognitive skills in the learning process can make learning independent and affect the improvement of learning outcomes (Bahri & Corebima, 2015). Metacognitive skills are believed to play an important role in many types of cognitive activity including understanding, communication, attention, memory, and problem solving (Howard, 2004). Thus, students who have good metacognitive skills will be followed by good learning outcomes. But the reality on the ground shows that metacognitive skills have not been empowered in schools. Teachers tend to evaluate learning outcomes which emphasize more on cognitive goals and pay less attention to metacognitive skills (Putra, 2012; Elyantari, 2016). Efforts to empower metacognitive skills in order to improve student learning outcomes are by applying learning strategies.

According to Tibrani (2017) the process to develop metacognition can be done by using strategies, approaches or learning models that require activities related to awareness and cognitive skills, forms of learning that allow the emergence of metacognition, for example, are Problem Based Learning, Project Based Learning, Inquiry Learning. According to Madang, et al., (2019) the application of the PBL model can make students to be actively involved in carrying out learning activities and to build their own knowledge. In line with Tan (2003) PBL trains students to develop and explore problems by increasing their awareness of different ways of thinking to solve a problem. On research Danial (2010) the application of the PBL strategy is able to improve the metacognitive skills of students. But in the application of the PBL learning model there are weaknesses, one of which is that not many teachers are able to

lead students to problem solving (Warsono & Hariyanto, 2014). This difficulty can be overcome by facilitated FILA chart design.

The application of the Problem Based Learning model will be better if it is facilitated by a learning design that is able to empower metacognitive skills as well, namely by using the FILA chart design. According to Baharom (2011) in PBL learning problems are designed that require students to be proficient in solving problems and have their own learning strategies and have the skills to participate in groups which are facilitated by the FILA chart design which includes facts, ideas, issues. learning (learning issue), and action planning(action plans). This is in line with research from Wulandari, et al. (2014) applying the Problem Based Learning (PBL) learning model with the FILA chart can increase the activity and learning outcomes of biology.

The use of the FILA chart can make it easier to implement the stages in the PBL model, but in the process of working on the FILA chart, students usually write the results of the FILA chart traditionally using cardboard, whiteboard or HVS paper. In this digital-based era of globalization, Students should use technology more in learning. As explained by Mui (2004) technology can be a tool that makes it easier for students to form an understanding of a teaching material. Education is increasingly needed, forcing the need for a technology to meet the needs of students (Sultoni, 2015). So that a in order to make it easier to implement the PBL model with the FILA Chart design, technology can be used for learning applications.

One of the technologies needed to meet the needs of today's students is softwareMindMaple. MindMaple can be interpreted as a mind map template software to find out how activity planning can be carried out (Nafi'ah et al., 2018). MindMaple can be used by teachers as a means of supporting learning that will be carried out during learning (Manurung & Pane, 2020). The learning process is carried out to achieve maximum learning outcomes. Maximum learning outcomes require appropriate learning strategies. Given that the importance of empowering metacognitive skills for students, but the application of the PBL model with the FILA chart design assisted by MindMaple in learning metacognitive skills in excretory system material has never been done. Then the formulation of the problem in this study is how the influence of Problem Based Learning model with assisted FILA Chart design MindMaple on students' metacognitive skills on excretory system material?

Theoretically, the results of this study are expected to be used as information and additional insight about the effectiveness of problem-based learning models and develop a theory of PBL models with the FILA chart design assisted by MindMaple in terms of the effectiveness of its application and can contribute to improving the quality of learning material excretory system. For students, it is expected to get new experiences and a varied learning atmosphere in learning and can improve metacognitive skills and maximum learning outcomes in the excretory system material. For teachers, it is hoped that this can be used as material for consideration in choosing and implementing effective, appropriate, and effective learning models.

Method

This study uses a quantitative approach, which is applied to class XI students of SMA Negeri 1 Palembang on the excretory system material. Therefore, the determination of the research class sample uses the Simple Random Sampling technique, which is a random sampling method without regard to the existing strata in the population (Sugiyono, 2016). In this study, the class was in a homogeneous state by considering that students were at the same grade level after the equivalence test and homogeneity test had previously been carried out and the material was based on the same curriculum and class division was not based on superior class. In this study, the method used is Quasi Experimental Design with the design form of Nonequivalent Control Group Design (Fraenkel et al., 2012; Sugiyono, 2016).

Experiment	**: O_1X 1 O_2**
placebo	**: O_1X 2 O_2**
Control	**: O_1 O_2**

Figure 1. Research Design

Information:
O1: Pretest (Initial Test) before being given treatment.
O2: Posttest (Final Test) after being given treatment.
X1: Learning using the Problem Based Learning (PBL) model and FILA assisted by MindMaple.
X2: Learning using the direct learning model and FILA chart assisted by MindMaple.

The research subjects were students of class XI SMA Negeri 1 Palembang in the even semester. Through a lottery, class XI IPA 6 (36 people) was assigned as the control class, class XI IPA 8 (36 people) was the placebo class and class XI IPA 7 (36 people) was the experimental class. The material in this study is the excretory system material in KD 3.9 analyzing the relationship between the structure of the tissues making up the organs in the excretory system in relation to bioprocesses and functional disorders that can occur in the human excretory system. The PBL used in this study comes from Baharom (2011) which consists of 7 stages, namely forming groups, identifying problems, writing ideas, learning issues, independent study, application synthesis, as well as reflection and feedback. FILA chart is a learning design from an example of PBL thinking that contains a FILA chart and problem scenarios. In the problem scenario, several problems must be solved by students in groups to find solutions to the problems given.

The FILA chart includes facts, ideas, learning issues, and action plans. MindMaple is a mind map template software to find out how activity planning can be done (Nafi'ah et al., 2018). MindMaple functions as a technology that can help students in compiling FILA chart. Before use MindMaple in learning, researchers have provided briefing related to tutorials on how to use the software MindMaple to students. Metacognitive skills in this study are students' skills in managing cognitive knowledge that involve cognitive regulation, namely planning skills, monitoring skills, and evaluation skills in answering questions, referring to the metacognitive skills rubric developed by Corebima (2009). The following is an example of a problem scenario in the study which can be seen in Figure 2.

Problem Scenario:

One Sunday morning, Sofian and her friends went out of the house to exercise. Sofian did a morning run with enthusiasm even though the weather was hot at that time, Sofian didn't pay much attention to it because she really liked running.

After finishing exercising, Sofian felt her body temperature increased and she also often sweated a lot from the pores of her skin. Throughout his running sports, he felt very thirsty and always wanted to drink water. When he went to the toilet, he noticed that his urine was a darker yellowish color than usual. Urine levels are also greatly reduced.

The next day, Sofian was feeling stressed all night because she had a lot of work to collect tomorrow. To wake him up, Sofian drank a few cups of coffee. However Sofian noticed that she went to pee more often than usual, Sofian's urine color tonight was also not darker than yesterday.

After she finished urinating, Sofian forgot to clean the toilet because she was too busy doing her work. A few moments later when Sofian wanted to pee again, she smelled an unpleasant and slightly pungent smell, then she realized that the smell was the smell of urine. Sofian immediately cleaned the toilet. He was very confused about this incident, why the urine can be yellow and smelly?

Sofian is worried about these three events and wants you to explain the matter to him. If you were a doctor, how would you explain the situation to Sofian?

Fila Chart Facilitator Table:			
Fact	**Idea**	**Learning issues**	**Action Planning**
Sofian's body temperature rose and sweated profusely after the day. ….	Running in the morning in hot weather can increase body temperature and affect sweat production. ….	Why body activities such as doing a lot of activity (running in the morning) and hot weather can increase sweat production?	Looking for additional information from: -reading in biology textbooks -read articles or journals related to problem scenarios -discuss with group friends Suggestions for Sofian: -If you want to exercise, it should be in a weather that is not too hot, after exercise you should have enough rest and drink lots of mineral water to avoid dehydration.

Modification of (Baharom, 2011)

Figure 2. Scenario Problem

Excretion system learning material was carried out in 4 meetings. The questions used in the study were validated by the validator before being analyzed. Researchers analyzed by conducting validity and reliability tests on 20 questions. The results of the validity test showed that there were 15 valid questions out of 20 questions. The results of the overall reliability test of the questions are 0.83 and the reliability test of valid items is 0.88 which indicates greater than 0.70. This shows that the question has high reliability. The reliability value used to determine reliable question data is≥0.70 (Arikunto, 2013). Then from the 15 valid questions, 3 questions with cognitive levels of C4 to C6 were selected to be used as research questions. According to Corebima (2009) states that metacognitive skills should be measured by description questions with cognitive levels C4 to C6. Data was collected through pretest and posttest through Google form. Data analysis and hypothesis testing were carried out through several stages. Test for homogeneity and normality, in this study using the SPSS 25 application. Test for normality using the test *Shapiro-Wilk* and Kolmogorov Smirnov, the data is said to have a normal distribution if a significance value > 0.05 is obtained and the homogeneity test uses the Levene test, the data is said to have the same variance if the significance value is > 0.05 (Usman & Akbar, 2006). Hypothesis testing used Analysis of Covariance (ANCOVA) to determine differences in the experimental group which had a higher range in *posttest* between the placebo and control groups. *ANCOVA* This is done by comparing the posttest average value with the pretest average as a covariate of students with the criteria if the significance is > 0.05 at the 5% significance level (α = 0.05) then Ho is accepted and the significance is < 0.05 at the 5% level. 5% significance (α = 0.05) then Ho is rejected (Usman & Akbar, 2006).

Results and Discussion

Based on Table 1, it is known that the average pretest scores of the control class, placebo class, and experimental class do not have much difference. The results of the observation of the average pretest and posttest in all classes showed that there was a difference in the average increase in metacognitive skill scores, namely the average final test score in the experimental class was higher than the control class and placebo class.

Table 1. Average Scores of Initial Test and Final Test of Metacognitive Skills

Class	Average Value			
	Pre-Test	Category	Final Test	Category
Control	16.42	Very less	46.71	Enough
placebo	16.31	Very less	51.68	Enough
Experiment	16.47	Very less	56.57	Enough

Based on Table 2, the scores for the pre-test and post-test of metacognitive skills in the control class, placebo class and experimental class obtained a significance value greater than 0.05 (Sig. > 0.05). So it can be concluded that the data on the pre-test and post-test in the control class, experimental class and placebo class on the value of metacognitive skills are normally distribute.

Table 2. Normality Test Results Metacognitive Skills Score

Score	Class	Kolmogorov-Smirnova		Shapiro-Wilk	
		Significance	Category	Significance	Category
Pre-Test Metacognitive Skills	Control	0.095*	Normal	0.489*	Normal
	placebo	0.080*	Normal	0.557*	Normal
	Experiment	0.115*	Normal	0.176*	Normal
Final Test Metacognitive Skills	Control	0.111*	Normal	0.453*	Normal
	placebo	0.142*	Normal	0.306*	Normal
	Experiment	0.200*	Normal	0.188*	Normal

Based on Table 3, it can be seen that the homogeneity test using Levene's test obtained a significance value greater than 0.05 (Sig. > 0.05) for the value of metacognitive skills. This value indicates that the three classes, namely the control class, placebo class and experimental class have equal or homogeneous abilities.

Table 3. Homogeneity Test Results

Score	Levene's test	
	Significance	Information
Metacognitive Skills	0.405*	Homogeneous

Data that normally distributed and homogeneous can be continued with the Analysis of Covariance (ANCOVA) test. The ANCOVA test was carried out by comparing the average value of the posttest and the average value of the pretest as covariates of students. Based on Table 4, it can be seen that the ANCOVA test on the Corrected Model value obtained a significance value smaller than 0.05 (Sig. <0.05) for the value of metacognitive skills. So Ha is rejected and Ho is accepted. So it can be concluded that the Problem Based Learning (PBL) learning model with the FILA chart design assisted by Mind Maple has a significant effect on increasing the metacognitive skills of students in class XI SMA on the excretory system material.

Table 4. Hypothesis Test Results

Tests of Between-Subjects Effects		
Source	Metacognitive Skills	
	Significance	Category
Corrected Model	0.001*	Significance
Intercept	0.000*	Real different
Class*Preliminary Test	0.107	No interaction
Initial Test (Pretest)	0.281	Not really different
Class	0.000*	Real different

Data that shows a statistically significant difference, then a further test is carried out LSD (least significant difference) aims to determine whether there is a difference between each treatment and to find out which treatment is the best among all classes. Based on Table 5, it can be seen that the LSD test using the Post Hoc Tests obtained a significance value smaller than 0.05 (Sig. < 0.05) for the value of metacognitive skills. This value indicates that the three classes, namely the control class, placebo class and experimental class have significant differences. The significance value of the control class to the experimental class on metacognitive skills is 0.000. While the significance value of the control class against the placebo class on metacognitive skills is 0.041. This shows that the significance of the control class to the experimental class is smaller than the placebo class. So it can be concluded that the best treatment for dizziness

Table 5. LSD Test Analysis Results (Least Significant Difference)

Score	***Post Hoc Tests***			
	Class (I)	**Class (J)**	**Significance**	**Category**
Metacognitive Skills	Control	placebo	0.041*	Real different
		Experiment	0.000*	Real different
	placebo	Control	0.041*	Real different
		Experiment	0.044*	Real different
	Experiment	Control	0.000*	Real different
		placebo	0.044*	Real different

The significant increase in metacognitive skills in the experimental class was due to from the stages of the PBL model with the FILA chart design with the aid of MindMaple it directs students to empower metacognitive skill parameters. According to the research results Fitriyani, et al. (2015) showed that the PBL learning strategy had a significant effect on metacognitive skills. Several other studies agree that PBL affects and improves metacognitive skills (Andriani, et al. 2019; Ismaroh & Azizah, 2014). Parameters of metacognitive skills tricked by PBL namely on cognitive knowledge (declarative, procedural, and conditional knowledge) and regulation of cognition (planning, monitoring, and evaluation skills) so that students must analyze various information to find the right solution. In line with the Tibetans (2017) factors that can affect the performance of metacognitive awareness, such as declarative knowledge, procedural knowledge and conditional knowledge. In line with Corebima (2009) metacognitive skills in its implementation involve metacognitive knowledge, so that there is a relationship between cognitive knowledge and metacognitive skills. From the research that has been done, it shows that there is a relationship between the steps of the PBL learning model and the FILA chart design (Baharom, 2011) on the strategy of empowering metacognitive skills, which is presented in Figure 3, the diagram below.

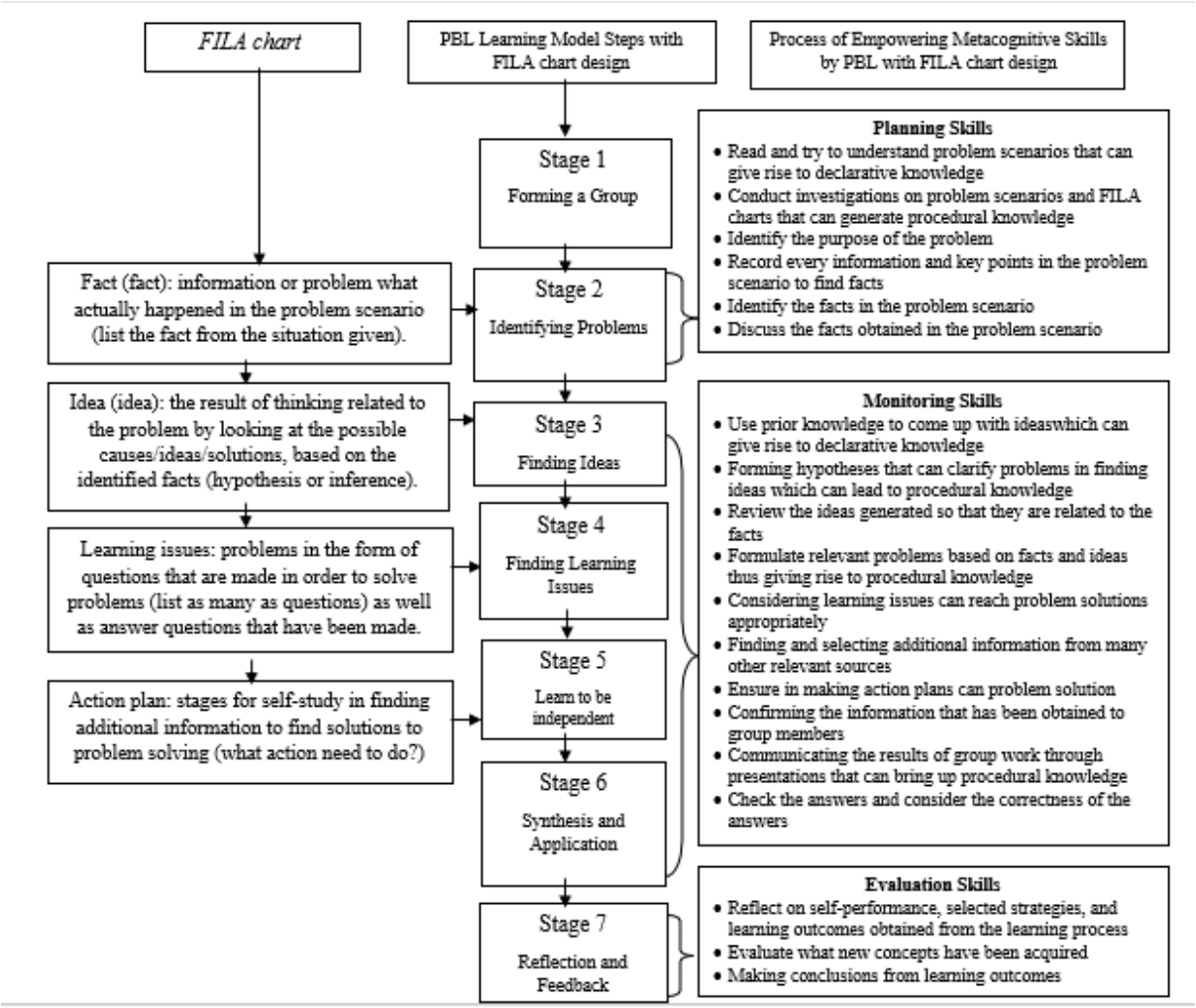

Figure 3. Chart of the Relationship between the PBL Model and the MindMaple-Assisted FILA Chart Design on the Empowerment of Metacognitive Skills

Based on Figure 3 above, it shows that there is a relationship between the stages of the PBL learning model and the FILA chart design so that it can empower students' metacognitive skills. Stages in the PBL model with the FILA chart design with the aid of MindMaple process-oriented and emphasize active involvement of students both physically and mentally by solving problems through technology, encourage students to think critically and analytically, regulate their cognitive processes in learning and involve awareness of how to learn, so that students can plan and design learning strategies, monitor understanding of the learning process and evaluate cognitive development by ensuring lessons are properly understood or not. The PBL learning model can encourage students to actively think more deeply, think critically in responding to a problem and formulate solutions to these problems (Siddiq, et al., 2020; Rahmawati, et al., 2021).According to Danial (2010) the PBL strategy provides strength for students in terms of empowering their metacognition. In line with Arends (2008) the effect of PBL strategy on improving metacognitive skills shows that the learning process based on inquiry or constructivist-based learning can grow and develop the process of knowing and their thinking process or better known as metacognition.

The application of the PBL model is facilitated by the FILA chart design. Students are required to identify the problem on the problem scenario sheet and then fill in the FILA chart table. According to Yuniarti's research (2014) the application of the PBL learning model with the FILA chart design in learning activities is able to empower metacognitive abilities because students are required to present facts, ideas, issues and action plans in solving problems that

can encourage activation of the conscious learning process, planning, designing. learning that will be carried out, monitor and reflect on the learning process that has been carried out. In line with Wulandari, et al., (2014) PBL also provides new innovations in biology learning, learning directly from the environment according to the context of real-world problems so that students feel challenged to always be involved, understand, and even construct their own knowledge. In the FILA chart table there are facts are taken through information or problems that actually occur in the problem scenario (list the fact from the situation given). The idea is the result of students' thinking related to problems by looking at possible causes/ideas/solutions, based on identified facts (hypothesis or inference). Learning issues are questions that are made in order to solve problems (list as many as questions), or problems that occur in problem scenarios, students look for problems created through interrogative sentences, as well as answer questions that have been made. Action planning is a stage for students to learn independently in finding additional information in finding solutions to the problems given. Additional information can be obtained through internet sources, articles, books, newspapers or conducting interviews with experts.

In working on the FILA chart, students in the placebo class only focused on books in seeking answers and teacher explanations, besides that students looked passive when conducting class discussions. The teacher directs students to ask questions that they do not understand, but students do not give a positive response so that the achievement of learning objectives in the placebo class has not been maximized and has an impact on increasing metacognitive skills which are not as good as in the experimental class. While in the experimental class the FILA chart is assisted MindMaple In the PBL model, students are able to identify problems, collect appropriate facts, analyze information, and choose the most effective problem solving through group discussions so that they can be active in asking questions, expressing opinions and ideas in their groups. According to Baharom (2011) the problems given are designed to require students to be proficient in solving problems and have their own learning strategies and have the skills to participate in groups facilitated by the FILA chart design. Applying metacognitive skills in the learning process can make learning independent and affect the improvement of learning outcomes (Bahri & Corebima, 2015). In line with Howard (2004) metacognitive skills are believed to play an important role in many types of cognitive activity including understanding, communication, attention, memory, and problem solving. According to Warouw (2010), metacognitive skills can be used to control cognitive processes.

In the process implementing the PBL model with the FILA Chart design, students use technology in the form of MindMaple. MindMaple can be interpreted as a mind map template software to find out how activity planning can be carried out (Nafi'ah, et al., 2018). Mind maple can be used by teachers as a means of supporting learning that will be carried out during learning (Manurung & Pane, 2020). MindMaple in using the FILA chart, it has advantages, namely: 1) it looks familiar; 2) the Lite version of the MindMaple application does not cost anything (free) and has a size of 14.28 MB and can be used offline; 3) Has a variety of visualizations supporting concept maps; 4) There are facilities to add images, photos, videos, website links; 5) make it easier for students to make FILA charts directly without using stationery and save paper usage; 6) Different kinds of options are also available, such as resizing, changing color, adding shape. Based on Table 4 on the hypothesis test obtained a significance value less than 0.05 (Sig. <0.05), it can be concluded that the Problem Based Learning (PBL) learning model with the FILA chart design is assisted MindMaple have a significant effect on increasing students' metacognitive skills. This is in line with research Manurung & Pane (2020) there is a difference in the learning outcomes of the experimental class students who were taught the PBL model using the mind maple of 77.55 and the learning outcomes of the control class students who were taught the PBL model without the mind maple of 74.20.

Conclusion

Based on the results ANCOVA test on the Corrected Model value obtained a significance value less than 0.05 (Sig.<0.05) can be concluded that learning innovation using PBL model with assisted FILA chart design MindMaple significant effect on the metacognitive skills of class XI high school students on the excretory system material. Among the three classes, based on further test data LSD (least significant difference), the average results of the metacognitive skills final test scores sequentially indicate that the use of the PBL model with the FILA chart design with the aid of MindMaple higher than the conventional learning model with the FILA chart design with the aid of MindMaple. Then use the conventional learning model with the FILA chart design with the aid of MindMaple higher than traditional classes or conventional learning models. The use of MindMaple software functions as a learning technology that can help make it easier for students to work on FILA charts directly without using traditional writing tools.

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