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Problem Based Learning Model on Higher Order Thinking Skills and Self Regulation of High School Students

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ABSTRACT

21st century students are required to have critical thinking and problem solving skills, creativity and innovation, communication, collaboration to train students to have social skills and global insight. In addition, self-direction (crom), global connections, local connections and the use of technology as a learning tool support Higher Order Thinking Skills. The application of appropriate learning models can support the achievement of these skills. The purpose of this research is to analyze the effect of Problem Based Learning model on the ability of Higher Order Thinking Skills and analyze the effect of Problem Based Learning model on Self Regulation. The research method used quasi experimental with nonequivalent control group design. The sampling technique used was purposive sampling. The instruments used were interviews, test questions, Self Regulation questionnaire and documentation. Hypothesis testing using Anacova test. The results showed a difference in Higher Order Thinking Skills on the application of the Problem Based Learning model with a significance value of 0,000<0,05, indicating the Problem Based Learning learning model affects Higher Order Thinking Skills. There is a difference in Self Regulation in the application of the Problem Based Learning learning model with a significance value of 0,000<0,05.

Introduction

The 21st century education brings changes to the learning process in schools. The learning system demands self-direction skills (self regulation), global connections, local connections and the use of technology as a learning tool that supports critical thinking skills (Chrestella, D. at.all, 2021). Indonesia implemented the 2013 curriculum marked by the Issuance of Permendikbud Number 67 of 2013, which aims to prepare students to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative and affective and able to contribute to the life of society,

nation, state and world civilization. But in reality, students still lack the ability to: 1) conduct investigations; 2) use media, procedures; 3) understand complex information; 4) theory, analysis and problem solving (Depdiknas, 2013). Therefore, the 2013 Curriculum was improved by emphasizing four important things in learning, namely strengthening character education, literacy, 4C skills (Communication, Collaboration, Critical thinking and problem solving, Creativity and Innovation) and Higher Order Thinking Skills (Malawi, et al., 2019).

Higher Order Thinking Skills (HOTS) emphasize the ability of students to solve problems in everyday life, so that learning oriented to HOTS is a method designed to train students in describing material, drawing conclusions, building representations, analyzing, and forming relationships by involving the most basic mental activities (Isbandiyah & Sanusi, 2019). The ability of Higher Order Thinking Skills is the ability to construct their own knowledge and can transfer the knowledge they gain to others. Higher Order Thinking Skills-oriented learning is divided into three main categories, namely: 1) knowledge transfer; 2) critical and creative thinking; and 3) the ability to solve problems with knowledge or experience that has been obtained and then adapt it to various contexts and situations (Saputra, 2016).

Cognitive processes can be divided into two types, namely Lower Order Thinking Skills and Higher Order Thinking Skills. Lower Order Thinking Skills include remembering, understanding, and applying, while Higher Order Thinking Skills include analyzing, evaluating, and creating (Anderson & Krathwohl, 2001). The government's efforts in the 2013 curriculum so that students can achieve various competencies with the application of Higher Order Thinking Skills, namely the ability to connect the information obtained with the information they already have, then use the information as a solution to a problem (Rosnawati, 2013).

The development of Higher Order Thinking Skills-based learning in the 2013 curriculum includes science learning principles using a scientific approach with the stages of observing, questioning, trying, and reasoning. However, in the implementation and implementation of learning in the classroom, problems are still found. Problems arise in learning because the learning process is not yet based on the ability of Higher Order Thinking Skills, learning is still theoretical and students are not used to exploring their creative ideas, so it is less meaningful for students (Deviana & Kusumaningtyas, 2019).

Achieving learning goals is not only with the ability of Higher Order Thinking Skills but, students also need to have Self Regulation (SR). SR is an active process where individuals continuously regulate and manage their thoughts, emotions, behavior, and environment to achieve academic goals (Zimmerman, 1999). Self Regulation is very important to grow in learners, because Self Regulation is an activity where learners actively participate in learning activities and learning environments, besides that learners can organize, monitor, train and use their abilities effectively, so that learners can gain a self-belief, self-confidence, and positive motivation of learners for their willingness to carry out learning (Jarvis, 2005). Learners who have higher Self Regulation obtain better learning outcomes than learners with low Self Regulation (Hamdi & Abadi, 2014). In addition, learners with low Self Regulation tend to believe that intelligence is innate and have high anxiety about achievement, while learners with high Self Regulation always try to achieve goals, challenge and acquire new knowledge, and always try to outperform others (Komarraju & Nadler, 2013). Therefore, in the learning process, students' Self Regulation needs to be improved.

Self Regulation in the learning process involves the thoughts, behaviors, feelings, and actions of students to achieve educational goals (Wayudi, et al., 2020). One of the main advantages of Self Regulation is metacognitive ability. Metacognition relates to the ability to organize, instruct oneself, monitor learning progress, and evaluate learning activities (Mukhid, 2008).

Learners who cannot manage their time well can lead to neglected tasks and less than optimal completion. As a result, these learners are at risk of failure or obstruction in achieving success. This factor of delay in

task completion is known as academic procrastination (Santosa, 2021). The failure or success of learners is not only influenced by their intelligence, but also by the habit of procrastinating task completion. There are several factors that influence the occurrence of delays in completing academic tasks, as follows: 1) psychological factors have a significant influence. Motivation, intelligence, and interest in learning beforehand can affect the tendency to procrastinate; 2) physiological factors Including health conditions and body disabilities owned of learners, which can affect the ability to be independent in learning; and 3) environmental factors also play an important role in encouraging learners to be independent in learning, such as support from family, mood, and environmental conditions (Hastuti, 2018).

Learners who have a high level of Self Regulation are learners who are able to plan and manage study time effectively, organize and manage information strategically, maintain motivation, and manage the environment that is a source of support in the learning process. On the other hand, learners who are in the medium category have the ability to organize a fairly good learning schedule and are able to motivate themselves. However, learners with low levels of Self Regulation tend not to have good planning and timing, lack of strategies in learning, low motivation, and underutilize available resources (Sari, 2014).

Learners still face difficulties in organizing themselves to make learning feel easier, so that students are less motivated to learn. Learners' learning achievement is very low and learners feel frustrated with the tasks given by the teacher (Latipah, 2010).

According to Syofrianisda (2018), in Biology learning activities students are required to continue to be active both physically, emotionally, and mental activities that must be implemented in scientific processes and attitudes. Therefore, from the problems that arise regarding Higher Order Thinking Skills and Self Regulation of students, it is necessary to renew and apply an appropriate learning model.

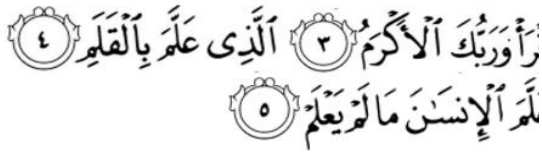
One of the innovative learning models that can train and improve the ability of Higher Order Thinking Skills and Self Regulation of students is the Problem Based Learning (PBL) learning model (Suratno, 2020), as well as research from Rosidah (2018) on improving the ability of Higher Order Thinking Skills in students by applying the Problem Based Learning learning model continuously in the learning process. And research from Riadi (2016) on the application of the Problem Based Learning learning model can train students' Self Regulation skills.

The Problem Based Learning model involves real problems as a starting point for learning with the aim of acquiring new knowledge (Surya, 2017). According to Ariyana, et al. (2018), Problem Based Learning is a learning model that combines students' real experiences in solving problems in the context of learning, so that learning becomes relevant to students' daily lives. This is in line with the opinion of Abdurrozak, et al. (2016), stating that Problem Based Learning encourages students to find solutions to real problems, which then produce new knowledge through the learning process. The advantages of Problem Based Learning include understanding concepts holistically, practicing cooperation skills, complex thinking, and skills in solving problems. Thus, it can be concluded that Problem Based Learning is a learning model that uses the thinking potential of students in solving problems that are relevant to everyday life (Rosdiana, 2019).

The Problem Based Learning model is highly recommended to be used in the Biology learning process, because one aspect of the ability of Higher Order Thinking Skills is Critical Thinking and Problem Solving. The Problem Based Learning model can actively involve students in independent investigations to solve problems, which in turn can create new knowledge from a learning process (Abdurrozak, et al., 2016). By applying the Problem Based Learning model, learners are given the opportunity to understand and analyze real-world problems using the learners' perspective and understanding (Yuniarti, 2016).

Learners who have knowledge in this world are the characteristics of knowledgeable people who will later be

raised by Allah SWT as stated in His word Q.S Al- Alaq verses 3-5 which reads (Al-Qur'an):



Meaning: "Read, and your Lord is the Most Exalted, Who teaches (humans) with the pen. He teaches humans what they do not know." (Q.S Al-Alaq verses 3-5).

In Tafsir Al-Qurtubi in Surah Al-Alaq verse 3-5 it is explained that knowledge is the main thing for humans, so read what you don't know and by reading it you will know everything because with knowledge, ignorance will be eliminated. So, the ability of Higher Order Thinking Skills and Self Regulation that is often well-honed will affect learning outcomes.

Method

The research was conducted from February to March during the even semester of the 2022/2023 academic year. The research method used was a quasi-experimental design with a nonequivalent control group design. The sampling technique employed in this study was purposive sampling, with students from class XI MIPA 8 SMA Negeri 5 Semarng serving as the control group and students from class XI MIPA 9 SMA Negeri Semarang as the experimental group. The instruments used in this study included interviews, pretest-posttest Higher Order Thinking Skills (HOTS) tests, pretest-posttest Self-Regulation questionnaires, and documentation. The hypothesis testing was carried out using the ANCOVA test.

Results and Discussion

Research on the effect of Problem-Based Learning model on the ability of Higher Order Thinking Skills and Self Regulation of class XI students was conducted at SMAN 5 Semarang . The number of samples in this study were 70 students who were divided into two groups, namely class XI MIPA 8 as the control group and class XI MIPA 9 as the experimental group. In the control group, the researcher applied the Discovery Learning model, while in the experimental group, the researcher applied the Problem-Based Learning model.

Table 1. Descriptive Statistical Results of Higher Order Thinking Skills

	Pretest Control Class	Posttest Control Class	Pretest Experiment Class	Posttest Experiment Class
N Valid	36	36	34	34
Missing				
Mean	41,11	62,22	43,82	78,53
Std. Error of Mean	2,666	2,327	2,603	2,318
Median	40,00	60,00	40,00	80,00
Std. Deviation	15,996	13,961	15,179	13,514

Based on Table 1, it states that the mean and median in the experimental class posttest have higher scores compared to the experimental class pretest, control class pretest and control class posttest, then the pretest and posttest in both the control class and experimental class have increased scores. However, the standard error of the mean and standard deviation on the experimental class posttest has a lower score than the standard error of the mean and standard deviation on the experimental class pretest, control class pretest and control class posttest.

Table 2. Descriptive Statistical Results of Self-Regulation

	Pretest Control Class	Posttest Control Class	Pretest Experiment Class	Posttest Experiment Class
N Valid	36	36	34	34
Missing				
Mean	138,28	151,06	137,15	158,97
Std. Error of Mean	2,571	2,557	2,525	2,801
Median	137,00	151,00	141,50	161,50
Std. Deviation	15,428	15,344	14,722	16,332

Table 2 depicted that in general, it states in general that the mean and median in the pretest and posttest in both the control class and the experimental class have increased scores, so that the mean and median in the experimental class posttest have higher scores than the experimental class pretest, control class pretest and control class posttest. The standard error of the mean and standard deviation on the experimental class

posttest also has a higher score than the standard error of the mean and standard deviation on the experimental class pretest, control class pretest and control class posttest.

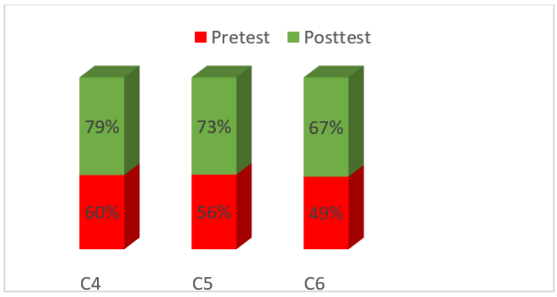


Figure 1. Diagram of Higher Order Thinking Skills Pretest and Posttest Results in the Control Class

Based on Figure 1, the results of the increase in pretest and posttest Higher Order Thinking Skills questions in the control class in the C4 cognitive domain with a percentage of 19%, C5 with a percentage of 17%, C6 with a percentage of 18%, it is concluded that the highest percentage increase in the cognitive domain is C4.

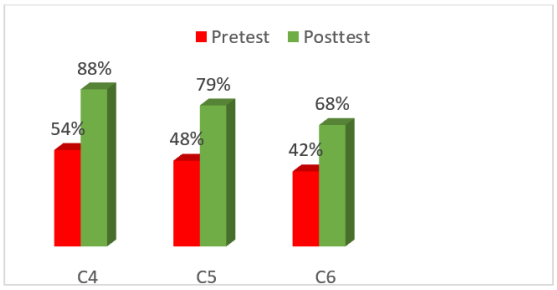


Figure 2. Diagram of Results of Higher Order Thinking Skills Pretest and Posttest Questions in Experimental Classes

Based on Figure 2, the results of the increase in pretest and posttest Higher Order Thinking Skills questions in the experimental class in the C4 cognitive domain with a percentage of 34%, C5 with a percentage of 31%, C6 with a percentage of 26%, it is concluded that the highest percentage increase in the cognitive domain is C4.

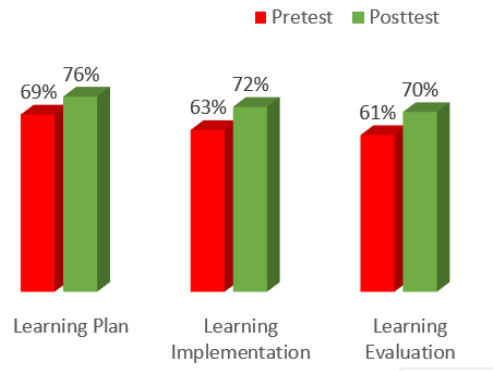


Figure 3. Diagram of Pretest and Posttest Self Regulation Questionnaire Results in Control Classes

Based on Figure 3, it can be explained that there is an increase in all indicators of Self-Regulation questionnaire pretest (study planning with a percentage of 69%, study implementation with a percentage of 63%, and study evaluation with a percentage of 60%) and posttest (study planning with a percentage of 76%, study implementation with a percentage of 72%, and study evaluation with a percentage of 70%) in the control class.

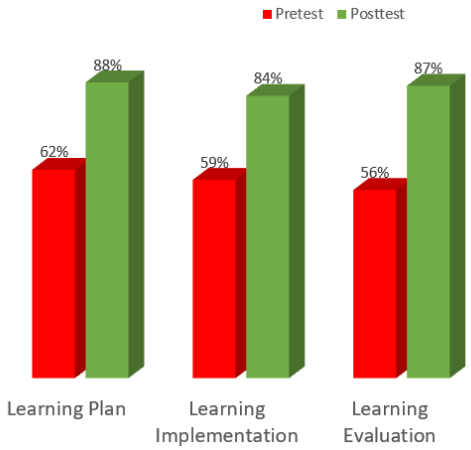


Figure 4. Diagram of Pretest and Posttest Self Regulation Questionnaire Results in Experimental Classes

Based on Figure 4, it can be explained that there is an increase in all indicators of the pretest Self Regulation questionnaire (learning planning with a percentage of 62%, learning implementation with a percentage of 59%, and learning evaluation with a percentage of 56%) and posttest (learning planning with a percentage of 88%, learning implementation with a percentage of 84%, and learning evaluation with a percentage of 87%) in the experimental class.

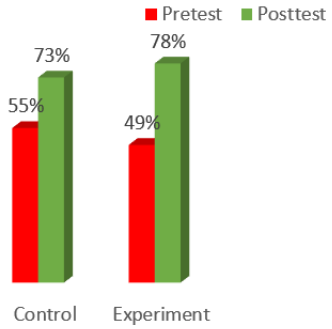


Figure 5. Diagram of Results of Higher Order Thinking Skills Pretest and Posttest Questions in Control and Experimental Classes

Based on Figure 5. it is known that the percentage of pretest questions about Higher Order Thinking Skills of students in the control class (55%) is higher than the experimental class (49%). While the percentage of posttest questions about Higher Order Thinking Skills of experimental class students (78%) is higher than the control class (73%).

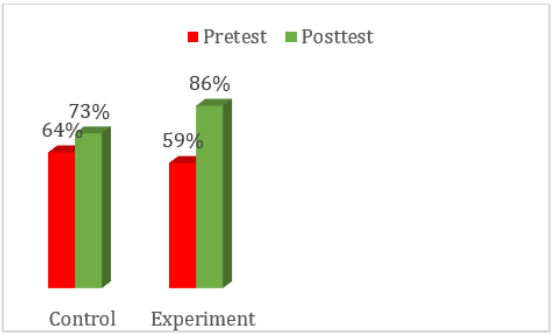


Figure 6. Diagram of Pretest and Posttest Self Regulation Questionnaire Results in Control and Experimental Classes

Based on Figure 6. it is known that the percentage of pretest questionnaire Self Regulation of students in the control class (64%) is higher than the experimental class (59%). While the percentage of posttest questionnaire Self Regulation of experimental class students (86%) is higher than the control class (73%).

1. The Effect of Problem-Based Learning Model on the Student Ability of HOTS

The results of the study, the average pre-test HOTS ability value of the control group on the excretory system material was 55%, the average post-test HOTS ability value was 73% in the sufficient category. The experimental group's average pre-test HOTS ability value was 49%, the average post-test HOTS ability value was 78% in the high category. The results show that the three HOTS indicators show an influence of the learning process in each class, in accordance with research by Royantoro, et al. (2018) and Pia, et al. (2021) which states that learning with the Problem Based Learning model has an effect on increasing students' HOTS.

Based on the calculation results, it can be concluded that the average ability of Higher Order Thinking Skills of students who use the Problem Based Learning learning model in the experimental class is better than the control class that uses conventional learning methods at school. The Problem Based Learning learning model provides advantages for students in terms of learning experiences that can train memory and critical thinking skills (Mardiani, 2020). When learners are confident in explaining their predictions, this can affect their ability to develop thinking skills (Nisa, et al., 2018). Therefore, the use of the Problem Based Learning model can improve the Higher Order Thinking Skills of experimental class students. In addition, the relationship between the two variables has a significance value of 0.000. With a significance value of 0,000<0,005, it can be concluded that the Ha hypothesis is accepted, which shows that the use of the Problem Based Learning learning model makes a significant contribution to improving the Higher Order Thinking Skills of XI MIPA class students at SMA X.

The differences that occurred between the control class and the experimental class in this study were caused by the different treatments given to the two groups. The Problem Based Learning model was applied to the experimental class, while the control class used the Discovery Learning model which is commonly used by teachers in schools. The use of the Problem Based Learning model in the experimental class allowed students to be more active and encouraged students to think critically in understanding the material about the excretory system. As a result, the average ability of students' Higher Order Thinking Skills in the experimental class was higher than the control class (Suratno & Sinabang, 2020). Although teachers in the control class have used a scientific-based learning model,

in practice students are still less able to think critically when conducting discussions without involving direct observation of the organs of the excretory system being studied. This causes the effectiveness of the learning model on students' Higher Order Thinking Skills in the control class to be lower than the experimental class (Pia, et al., 2021).

Higher Order Thinking Skills can be developed through a learning approach that integrates real problems in everyday life. These real problems can help learners understand the concepts in the learning material and effectively improve their Higher Order Thinking Skills (Yuliati & Lestari, 2019). In this context, the Problem Based Learning model provides opportunities for learners to identify, explain, and analyze problems using their own reasoning (Abosalem, 2016). The implementation of Problem Based Learning model specifically helps learners in doing these activities. For example, in this study, experimental class learners made predictions and then analyzed, evaluated, and connected them with facts and theories related to the concept of the excretory system. This directly helps learners in practicing Higher Order Thinking Skills and results in improved learning outcomes (Klein, 2011).

The Problem Based Learning model has a more effective influence on students' activeness in arguing and solving problems, as shown by Widana's research (2017). This research shows that the metacognitive dimension is generally measured through the ability of Higher Order Thinking Skills. The metacognitive dimension includes the ability to connect different concepts, interpret, solve problems, choose ways to solve problems, discover new concepts, argue, and make the right decisions. This ability appears when experimental class students are involved in discussion activities. This shows that the application of the Problem Based Learning learning model can improve students' Higher Order Thinking Skills by training their metacognitive dimensions (Pia, et al., 2021).

Problem-based learning models are proven to be more effective because they allow students to actively develop their knowledge, as stated by Ertikanto (2016). Because HOTS skills involve thinking at a higher level than simply memorizing or retelling information from others. Problem-based learning models intrinsically combine HOTS elements in every stage of their syntax. In the fourth stage, namely the stage of developing and presenting the results of the work, related to solving the given problem, it requires students' ability to analyze, evaluate, and create. The ability to analyze begins in the third stage when students make hypotheses related to the problem to be solved. However, this ability is re-emphasized in the fourth stage when students create artifacts as a result of problem solving. This ability can be in the form of various forms of work that are products of problem solving. Evaluation and creation skills are also seen when students are asked to create work, and the complexity of the artifacts produced is an indicator of the level of HOTS ability they have (Prastiwi, 2016).

Riadi (2016) stated that the Problem Based Learning learning model is effective in training students' critical thinking skills and plays an important role in improving the ability of Higher Order Thinking Skills. The implementation of the Problem Based Learning model in learning activities in experimental classes has shown positive results in improving students' Higher Order Thinking Skills. The importance of using an effective learning model by teachers in encouraging students to remain active in learning can also be observed (Rosidah, 2018). However, it should be noted that the effectiveness of the Problem Based Learning model in improving students' Higher Order Thinking Skills may depend on the material indicators applied (Royantoro, 2018). In addition to the learning model, other factors such as learners' ability and time duration also play a role in improving the ability of Higher Order Thinking Skills. Therefore, the results of the effectiveness of the Problem Based Learning model may vary when applied to different research samples (Jennifer, 2013; Khasanah, 2018; Rofi'ah & Permana, 2020; Setiawati, 2019).

2. The Effect of Problem Based Learning Model on Self Regulation

Based on the research that has been applied, Self Regulation uses three indicators, namely learning planning, learning implementation, and learning evaluation. Based on the results of the Self Regulation questionnaire analysis in Figure 6. shows the acquisition of the average value of pretest Self Regulation in the control class on the material of the excretory system of 64%, while the average value of posttest Self Regulation is 73% with a sufficient category. The experimental class with an average pretest Self Regulation value of 59%, while the average posttest Self Regulation value of 86% with a high category. This shows that there are similarities between the control class and the experimental class. A significant increase in Self Regulation ability in the experimental class can occur due to the use of the Problem Based Learning learning model which strongly emphasizes aspects of independence that arise from learning planning and learning implementation. According to Zimmerman (1999), Self Regulation is the ability of learners to independently organize their learning strategies. Learners have awareness of their own thinking, plan appropriate learning strategies, use the necessary resources, respond appropriately to feedback, and evaluate the effectiveness of their actions in the learning process.

Based on the data analysis, it can be concluded that the students' Self Regulation questionnaire score on the excretory system material in the experimental class is higher than the control class. This shows that the use of the Problem Based Learning model, which involves students in real problems, is able to improve students' Self Regulation (Latipah, 2010). In this context, through real problems, learners can discuss, present, plan learning strategies, and evaluate the effectiveness of the learning process, which overall contributes to improving learners' Self Regulation (Zuraida, et al., 2017). The advantages of the Problem Based Learning model that motivates learners' learning, encourages discussion and presentation, increases collaboration between learners, involves them in retrieving information and demonstrating their knowledge in a real-world context, and provides opportunities to organize the learning process, all of which are in accordance with improving learners' Self Regulation (Maghfiroh, et al., 2016).

According to Sulasmi (2014), each step in the formation of Self Regulation can be applied to the stages of the Problem Based Learning model. The first stage of Problem Based Learning, which is giving problems, is part of the forethought phase in the formation of Self Regulation. At this stage, learners conduct task analysis by formulating goals, plans, and learning strategies. In addition, this stage also involves the formation of motivation, such as increasing self-efficacy and having expectations for success (Zimmerman, 1999). Providing problems to learners in the context of Problem Based Learning can encourage them to formulate learning objectives, identify the sources of information needed, create a learning plan, organize roles in the group, and communicate about the plan with other group members. If the first stage of the Problem Based Learning model can be passed well, learners can successfully analyze the task while building internal motivation within themselves (Fitriani, et al., 2019).

According to Sulasmi's (2014) view, the second stage in Problem Based Learning involves the important role of the teacher in guiding learners to produce solutions, which is related to the volitional (performance) phase in the formation of Self Regulation. In this stage, learners perform a series of activities, including searching for information and analyzing the information obtained. This series of activities encourages learners to monitor themselves in the process of gathering information. Learners are trained to monitor and control themselves, including adhering to previously developed plans and strategies. In addition, learners are also taught to control themselves when sharing information with other learners and respect the opinions of group mates. Collaboration among learners in discussing and selecting relevant information to solve problems also provides

opportunities for them to learn self-control (Marfu'i, 2018).

According to Sulasmi (2014), the last stage in the implementation of Problem Based Learning is analyzing and drawing conclusions from a problem, which contributes to learners' ability to self-reflect. Through this reflection process, learners can evaluate whether the process they have gone through is in line with the goals and expectations they have set when the problem was given. This self-evaluation helps learners to determine whether they have succeeded or failed in going through the process. The results of this self-evaluation then encourage learners to give reactions, both positive and negative, which in turn encourage them to improve the strategies that will be used in the next process. Learners' ability to improve their strategies shows their ability to adapt to the learning process. Thus, the third stage of Problem Based Learning trains learners to evaluate, attribute, react, and adapt, which in essence is the ability of learners to self-reflect (Taylor & Anne, 2009).

Based on observations made in classroom learning, students are actively involved in interactions between teachers and fellow students. They are active in asking questions, answering questions, listening to presentations, and discussing in groups when working on the Learner Worksheet (LKPD). When the teacher asks questions, learners compete with each other to answer them. Students' activeness in learning continues to increase from time to time. The use of the Problem Based Learning model has an impact on improving learning activities in the classroom. There is an increase in learning activities in the application of the Problem Based Learning model through an increase in the number of questions asked by students, both inside and outside the classroom (Anggraini, 2019; Ormrod, 2009). The pleasant learning environment in the group work system in the application of the Problem Based Learning model can help learners meet the needs of competence, autonomy, and interconnectedness, and provide ample opportunities for them to discuss learning materials. This gives learners ample space to express thoughts, opinions, feelings, and problems related to the subject matter (Dewi, 2019).

According to Azninda & Setyarsih (2018), the use of the Problem Based Learning model can improve students' learning achievement and motivation. It can also help learners feel confident and actively involved in classroom discussions, and improve their understanding of learning concepts. In implementing Problem Based Learning, learners can gain an understanding of the learning material in an atmosphere that they find comfortable and enjoyable. As a result, learners become more optimistic in participating in learning activities (Hamdi & Abadi, 2014).

Based on the research conducted, it can be concluded that the use of the Problem Based Learning model that integrates authentic problems in the excretory system material has a positive impact on improving students' Higher Order Thinking Skills and Self Regulation. The Problem Based Learning learning model allows students to independently discover the actual learning concepts and plan the learning process. Thus, students become more interested and active in participating in lessons (Prastiwi, et al., 2016). Through independent learning activities, finding their own information through LKPD and discussing in groups, the Problem Based Learning learning model can overcome students' boredom and increase their interest in learning (Ayunda, et al., 2023). Learners' activities in the Problem Based Learning learning model can increase curiosity and collaboration between learners, allow them to think independently and together, and gain knowledge that is durable and easy to remember. This can affect students' concept understanding of the material taught (Herzon, et al., 2018). Sudarisman's (2015) statement also supports this by explaining that the learning process will be more active, creative, effective, and fun if the teacher provides opportunities for students to discover rules including concepts, theories, and definitions through relevant examples.

Conclusion

Based on the research results, it can be concluded that: Problem-Based Learning has an effect on Higher Order Thinking Skills and Self-Regulation of high school students.

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