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BIOLOGY TEACHING DEVICES GROUNDED IN PROBLEM BASED LEARNING AND METACOGNITION

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ABSTRACT

Problem-based learning (PBL) in biology has been considered as one of the innovative contextual teaching designs, since students learn biology from problems (cases) of real life and it potentially encourage students' metacognition. This research was aimed at developing biology teaching devices, grounded in problem-based learning approaches and metacognition habits, and identifying their effect on students' learning achievement and metacognition. The field testing was implemented on 33 students, using pre-experimental design group single pre-test – post-test design. Experimental data was analysed quantitatively. The findings showed that (1) there was a significant effect of the use of the innovative lesson devices on student learning achievement and metacognition which is measured usingquestionnairemetacognitive (MAI). Metacognition scores were more likely to be improved, before and after treatment (0.36 middle). High metecognition scores were on planning aspects (0.42 middle) and the lowest score of metecognition was on executing aspects (0,29); (2) learning achievement was also improved, before and after treatment. N-gain score was 0.52 (middle). The total contribution of the lesson design on learning achievement and metacognition was classfied 'highly effective'. Biology teachers could use the product to improve the quality of their teaching learning processes.

Key Word: biology teaching devices, metacognition, problem based learning

INTRODUCTION

Learning devices are associated with the quality of learning, what students do in their learning are influenced by the design created by their teacher. Learning devices is an instructional design developed to achieve the purpose of the lesson. Learning devices contained materials to be studied, a clear mirror of learning goals, and activities designed by teachers to achieve learning goals. Learning materials that are interesting and packed in instructional design gives the emotional impression for the students. One of the interesting topics in learning biology is human Immune System, full of problematic cases of immune disorders. Disease is one of complicated anomaly of human body regulation that demand high-level thinking, and metacognition of students.Science teacher can develop learning devices on the basis of human body abnormality to suport metacognition.

Problem-based Learning (PBL) is commonly considered as one of the right approach in using a problem (case) as a foundation of student learning activities. PBL is a learning approach that encourages students work in groups to solving problems, and encourage students to learn (Akcay, 2009). PBL help students develop an ability to think. PBL is designed to support a high-level thinking, including a metacognition (Dyahwati et al., 2013, Lubana et al., 2013). PBL can be used to help to train students metacognition ability that will lead to solving the problem, especially metacognition ability in this selfmonitoring and planning (Biryukov, 2004). Metacognition has an extremely important role in this raise awareness khsusnya individual learning process. Metacognition has an extremely important role in this individual learning processes.

Metacognition is a cognitive thinking process. Livingston (2002) compared the knowledge and experience of metacognition as two sides in one coin of theory and practice. Suherman et al., (2001) metacongnition is a word that relates to what is known about himself as an individual, who still learn, and how control and adjust his paths of learning. Metacognition is a form of human ability to see themselves so that what they do can be controlled optimally. This ability is

verified as human ability to solve problems. Downing, (2008). Toit, S. D & Gary, K (2008) mentioned that metacognition covered at least three aspects of knowledge, knowledge of knowledge, knowledge of conscious monitoring, and knowledge of cognitive avaluation. Students with strong metacognition is defined as students who are able to plan, to monitor and to evaluate their own learning. Students are people with better- coordination, information management, and evaluation.

Many experts have already established a compeling reasoning that metacognition can encourge students to better thinking. Cooper (2004) citing Flavel (1981) metacognition is knowledge of all cognitive processes. This is knowledge of learning, of himself, and of how to monitor his learning. Pierce (2003) classified metacognitive awareness into three categories such as declarative, procedural, and conditional knowledge. Imel (2002) defined metacognitive awareness as knowledge of how to conduct a task, of conditions required to accomplish the task, and of how to monitor the task excuted. Metacognition is related to the successfullness of learning. The real question faced by biology teachers is how to ground, translate, implement a theory of metacognition into biology teaching processes. This study was aimed at (1) designing lesson plan grounded in PBL and metacognition and (2) identifying the effects of lesson plan on student metacognition.

METHODS

This research was undertaken by Research and Development steps, translated into four steps: 1) doing needs analysis, 2) developing a product, 3) field-testing the products, and, 4) doing a revision. Needs analysis was conducted to collect data about what is expected by national curriculum, academic characteristic of students, and the used biology lesson plan by biology teachers. Based on the priliminary data collected by content analysis, observation and text analysis of teacher lesson plan, it was found that alternative lesson designs needs to be developed. Teaching learning devices grounded in PBL and Metacognition were then developed. They were sylabus, daily lesson plan, student worksheet, and assessment instruments, all of them were grounded in PBL and metacognition. To improve validity of the teaching devices, they were validated by biology content experts, and biology educator as theoritical validators. Grade XII students were also invited to prove the readability of the teaching learning materials. Field-testing was undertaken to prove the effect of the use of the teaching devices upon student metacognition, using pre-experimental design, “One-Group Pre-test-Post-test Design". MAI (Metcognition awareness) and student reflective journal learning were used as psychology scale to measuare metacognition. Leaning achievement was measured by pre-test and post-tests. N-Gain test was used to identify the improvement of metacognition and learning achievement.

RESULT AND EXPLANATION

Biology Learning Device grounded in PBL and Metacognition

The biology teaching devices were consisted of syllabus, daily lesson plan, teaching materials, student worksheets, and assessment tools. All of these products were coloured by PBL and the integration of metacognition, as presented by Table 1 below.

Table 1. Biology Learning Devices

Learning Devices	Components	Explanation
Syllabus and /or Lesson Plan	Basic competency learning indicators	This learning indicator use metacognitive thinking action, such as planning, monitoring, implementing, and reflecting.
	Learning material	Biology learning material are presented by problem-solving procedures, students were introduced by human immune system abnormality first, then from biology cases they learn other related concepts of biology ((immune system, non-specific, spesific immune, etc),
	Learning activities	Students learn biology by PBL procedures of learning, not by rote learning.
	Learning Assessment	Both formative and summative assessment are used to portray student performances, not just ‘a paper and pencil test’.

Student Book	Content	Teaching materials contains common cases and some questions to be addressed to encourage student understanding of immune system.
Student worksheet	Steps of Student work	This worksheet is occupied by problems, cases, and reflective questions, and making reflective journals.
Assesment Tools	Types and Procedures	Formative and Summative alternative assessment were used.

This table 1 underlined the difference between ordinary biology lesson planning and ones with the translation of PBL and metacognition. Cases were used as triggering factors for learning. From cases, students learn other related biology concepts. This fenomena is differen from the direct instructional planning,where teachers directly introduce some related topis of biology. Some reflective questions posted on student worksheet, student book, encourage students think critically. This fenomena is realted to what was mentioned by Wulandari (2011) who developed leason planning, grounded in PBL and metacognition. Wulandariet al., (2011) Said PBL was a constructive way to learn some issues. PBL does not encourage the teacher present a lot of information, but PBL helps students develop ways of thinking, problem solving, adult learning, and becoming an independent learners (Sugiman, 2007). Downing (2010) also argued that PBL could be used to ideally support metacognition skills, because students were more highly motivated to learn biology. Students with high motivation are usually effective in their learning.

Learning Result on Immune System

Data Analysis indicated there was significant improvement in the students understanding of immune system, as calculated by N-gains score, as presented in Table 2.

Table 2. The *pre-test* and *post-test* and N-gains

Student Group	N	Average Pre-test	Average Post-test	Average N gain	Note
High	10	57.60	82.00	0.57	Medium
Medium	17	56.25	77.63	0.49	Medium
Low	6	49.33	73.67	0.47	Medium
All	33	55,64	78,61	0.52	Medium

This condition was caused by the process of learning, different from usual activities of students, who were more likely to be passive. Students were more active in asking, questioning, and reflecting. Other related learning products, such as writing reflective journal every day, confirmed that their learning was different. This inference seems to be similar to what is found by Wulandari et al., (2011) underlining that PBL affected significantly to student learning achievement.

Student Metacognition

In this study, student metacognition was identified when students 1) plan their learning, 2) monitor their learning, 3) take action, 4) evaluate their action. Table 3 summarized some of their aspects of metacognition. When students were involved in their class, teachers provided them with LKS (student worksheet) asking students to answer some major problems of immune system, such as what do you know this case, how do you study it, and after reading the case, student answer some more reflective questions (how do you know that your answer is accepted). Before class was over, student did writing a journal, to address some more questions, such as what happens, what do you feel, whant did you learn). At the end of research periode, students were assessessed metacognitively by MAI. Student metacogniton was then presented by Table 3.

Table 3. Studen Metacognition

No	Aspects	Before		After		N-Gain
		Average	Metacognition	Average	Metacognition	
1	Planning	63.74	Middle	79.22	High	0.42
2	Information management	63.72	Middle	74.83	High	0.30
3	Monitoring	64.18	Middle	76.62	High	0.34
4	Implementation	61.11	Middle	72.47	High	0.29
5	Evaluation	63.45	middle	77.65	High	0.38

In terms of planning, students seemed to be more improved after treatment. This condition was related to the habit of writing reflective journals by each of students, In their writing journals, students became aware of what happened, what they felt, and what they actually learnt. Through this process of thinking, students became aware of what they would do in the next agenda. Byurkof (2004) mentioned that PBL could help develop student's metacognition, especially their ability in planning.

As a whole, metacognition of students seems to be improved. There were data of metacognition before and after treatment, the use of biology lesson plan grounded in PBL and metacognition. This learning devices boosted metacognition. Table 4 presents the metacognition level before and after the use of the learning devices.

Tabel 4. Metaconition level

Arange score (%)	Metacognition level	Before	Avrage	After	Average
80-100 %	Very high	-		8	82.29
70-79%	High	3	72.22	22	75.30
60-69%	Middle	24	64.03	3	68.89
45-59%	Low	6	57.22	-	
>44%	Very low	-		-	

This table 4 indicates that the level of metacognition tends to be more better before and after the implementation. Tosun & Erdal (2013) stated that PBL was more effective in improving level metacognition of students who have limited knowledge of science. Some authors also mentioned that metacognition relates to motivation, and motivation of learning improve learning achievement (Imel, 2002).Metacogntion encourages students to be reflectively aware learners. Students are capable to manage their cognition, their limitedness of their efforts, and then to improve their performance in achieving the goals.

Cooper (2004) citing Flavel (1981) metacognition is knowledge of all cognitive processes. This is knowledge of someone's learning, of himself, and of how to monitor his learning. Pierce (2003) classified metacognitive awareness into three categories such as declarative, procedural, and conditional knowledge. Imel (2002) defined metacognitive awareness as knowledge of how to conduct a task, of conditions required to accomplish the task, and of how to monitor the task excuted. In summary, if students with strong metacognition awareness, he is more likely to be a successful learner.

CONCLUSION

Under the new curriculum (K13), contextual teaching and learning such as PBL is considered as the focus of learning design. PBL can encourage students to be more active in class because of its power of real cases in supporting student metacognitively thinking. If real problems of biology was introduced in biology teaching design, students are more emotinally interested. Human immune system is one of human regulation topics that can be used to trigger student thinking since there are many problematic cases related to student life. Disease is one of complicated abnormality of human body regulation that demand high-level thinking, and metacognition of students.

Biology teacher can develop teaching devices on the basis of human body abnormality to suport metacognition. Biology teaching devices grounded in PBL and metacognition was the product developed to

address teachers'needs of alternative biology teaching tools at SMA Negeri Pecangaan Jepara Indonesia. This teaching devices were already verified by experts and potentially used by biology teachers to support the quality of thinking.

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