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Improving PBL in Empowering Meta cognitive Skill of Students

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Abstract

Objective: Problem-Based Learning (PBL) is a potential constructivist learning strategy that empowers students' Meta cognitive skill. PBL focuses on problem, involves thinking activity to solve problems, and correlates to cognitive function of students. **Methods:** The implementation of PBL reveals various benefits, but there are also some weaknesses in this learning strategy. Thus, it is necessary to implement a certain learning strategy that can cover the PBL weaknesses, such as Reading, Questioning, and Answering (RQA) learning strategy. RQA is a new learning strategy developed based on a fact that almost all students do not read the next lecture materials, causing failure of learning strategy planned and finally the students' comprehension becomes low. RQA is also potential to empower students' Meta cognitive skill. **Findings:** The integration of RQA and PBL learning strategy is called PBL-RQA learning strategy. This study was a quasi-experimental study designed to compare the effect of PBL, RQA, and PBL-RQA learning strategies on the students' Meta cognitive skill of Faculty of Mathematics and Science, State University of Makassar. **Application:** The results of the study showed that the potency of PBL learning strategy in empowering the students' Meta cognitive skill has been increased by integrating it to RQA learning strategy. The meta cognitive skill mean score of the students taught by PBL-RQA learning strategy was 21% higher than that of the students taught by PBL and 26.9% higher than that of the students taught by RQA learning strategy.

Keywords: Answering, Meta Cognitive Skill, Problem-Based Learning, Questioning, Reading, PBL-RQA

1. Introduction

To date, the Basic Biology lecturing strategy in Faculty of Mathematics and Science of State University of Makassar is still dominated by teacher centered strategy. The lectures are carried out in order to acquire cognitive learning outcomes and do not empower the students' Meta cognitive skill yet. This causes the students' cognitive skill low for they are not yet guided to be self-regulated learners. The students do not know the cognitive skill potential (self-assessment) and cannot manage and monitor their own cognitive skill (Self-management and monitoring). Stated that the development of Meta cognitive skill helped students to be self-regulated learners[1]. A self-regulated learner is responsible to the improvement of his/her learning and, thus, needs to adapt his/her learning strategy to reach the learning objective.

In[2] proposed and Metcalfe[3v] defined Meta cognition as an act of "think to think". Besides, Meta cognition involved knowledge of how to apply and analyse thinking, how to draw conclusions from the analysis result, and how to implement the learning appropriately. In[4] proposed showed the difference between cognitive tasks (recalling things learnt to resolve present tasks or problems) and Meta cognitive tasks (monitoring and guiding the process of problem solving), and emphasized the importance of learning more to think. Meta cognition plays an important role to succeed learning[5].

Similarly[6] argued that meta cognition enabled students to obtain many advantages during learning activities and also influenced both practice and care of cognitive strategy.

Meta cognitive skill is believed to play a key role in various cognitive activities, including comprehension,

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communication, attention, memory, and problem-solving[7]. In[8] stated that as thinking and learning skills are the examples of meta cognition skills, students were able to learn to think of their self-thinking process, as well as implemented unique learning strategies to do self-thinking through difficult tasks. The empowerment of thinking and meta cognition skills by implementing appropriate learning strategies is necessary for students to be self-regulated learners. The research was conducted by[9] showed that meta cognition skill is affected by learning strategy[10].

Learning strategies that are potential to arouse meta cognitive skill should be based on constructivist approach such as Problem Based Learning (PBL). This is in line with[11], and[12] statement that PBL is potential to empower meta cognitive skill. PBL is based on a thought that learning is not a memorizing concept, yet it is an interaction process between individual and environment. In[13] stated that PBL is also capable of developing skill needed in knowledge[14] since it can develop high order thinking skill as critical thinking, problem-solving, learning resources finding and implementation, self-learning, cooperative skill development, and long-life learning[15]. PBL can be applied in University level since it is based on problems, involving thinking activities to solve problems, and correlates to the cognitive function of students[16].

One of the aims of undergraduate education is to facilitate students to develop the functional knowledge which allows them to integrate the academic knowledge base (declarative knowledge), as well as skills required for that profession (procedural knowledge) and the context used to solve problems (conditional knowledge)[17]. Similarly[18] stated that PBL basically needed different approach in implementing knowledge to solve problems, and this involved meta cognition process within knowledge functions. Even though there are many ways of problem based learning, all of them need students be successful to monitor and guide the problem solving process, recall memories from concept and previous learning process to overcome the current problems. Generally, PBL stages of learning motivation context are organized by real life problems; learners' activation is facilitated by group work, peer discussion, facilitator interaction, and relevant basic knowledge development is constructed and applied to cover the problems, and furthermore the problems are reflected based on declarative, procedural, and conditional knowledge. Therefore, problem based learning should, at least, ideally be aligned to the development of students' meta cognition.

In[19] suggested that cognition focussed on problem solving, whereas meta cognition focussed on the process of problem solving. In order to resolve problems effectively, students need to understand the function of their mind. In other words, students need to know how they carry out important cognitive tasks such as recalling, learning, and problem solving. Hence, PBL have to encourage the students' meta cognitive development significantly compared to other non-problem based learning strategies which do not need similar reflective performance. In[20] stressed the role of students' belief in thinking and creating focus point that if they perceived that they could solve problems, they would tend to work better.

The implementation of PBL reveals its various advantages. However, there are also some weaknesses of this learning strategy. In[21] and studies showed that the implementation of PBL in university level spent much time compared to that of conventional strategy[22]. In also stated that it was difficult to implement PBL in every class. PBL was less appropriate for students who cannot truly understand values or scope of problems and their social content[23]. Furthermore, Ward and Lee stated that there were a few materials available for PBL strategy. The existing curriculum guidance and text books do not contain any issues needed[24]. It disables both students and teachers to raise relevant issues in learning.

In stated that PBL needs many learning materials that encourage students to use a lot of resources in terms of text books to find information[22]. Students are also difficult in some ways to overcome the problems given due to the lack of the students' initial knowledge about the topic raised, due to the lack of reading habit of the students.

It needs another appropriate learning strategy to overcome the weaknesses of PBL, for example Reading, Questioning, and Answering (RQA) learning strategy. RQA is a new learning strategy which was developed based on the fact that almost all students did not read relevant materials for the next lecture activities, causing difficulties or even failure to the implementation of the planned lecturing strategy and finally causing the students' comprehension is low or even very low. The implementation of RQA could force students to read learning material assigned, so the learning strategy planned could be implemented well and their

understanding of learning material could be improved 100%.

Through the implementation of RQA, students' meta cognitive skill is expected also to be improved, because in RQA learning students are obliged to read and to comprehend the text read, also to find the substantial parts of the text. The series of activities is one of meta cognitive strategies. RQA was able to empower students' meta cognitive skill, and thus would improve students' cognitive learning outcomes. According to[6], the impact of meta cognition on learning achievement of someone depends heavily on the motivation pattern. In stated that it explains the possibility of relationship between meta cognition and motivation in influencing learning achievement[25].

RQA is expected to be able to overcome the weaknesses of PBL. The weaknesses can be solved by RQA learning strategy having stages where students can read as much literature as possible to find problem solving. In[26] stated that during problem solving process, students might explore several disciplines and widen their basic knowledge through independent study and cooperative work with their peers. In[27] saw PBL as a replication of real life situation and became an inherent interdisciplinary, which facilitated students to understand how different knowledge interacted to resolve problems.

RQA learning strategy helps students to prepare themselves to study so that they possess initial knowledge related to materials being discussed, "forces" students to read in order to enable them to find problems and solutions, so that the time allocated to solve the problems is shorter. Another factor that might cause the low cognitive learning outcome in Basic Biology course is students' low interest in reading learning material in order to prepare themselves for the next lecture, so the initial knowledge of students during the lecturing activity is less. In suggested that students should possess initial knowledge functioning as a basic to construct the next knowledge. Thus, it can overcome the weaknesses of PBL taking more times.

The RQA syntax integration to PBL syntax can be called PBL-RQA. The integration of both strategies is based on that when several problems are to be solved, then RQA can be an effective way to provide deep learning before conducting sharing activity with peers during class presentation[28]. The integration of RQA and PBL stimulates students to read a lot and find information. Besides, it is expected to be able to improve PBL potential in empowering students' meta cognitive skill. This article aim is to examine the potential of PBL, RQA, and PBL-RQA in empowering students' meta cognitive skill.

2. Method

This study was carried out in a quasi-experimental design to compare the effect of PBL, RQA, and PBL-RQA learning strategies on the students' meta cognitive skill of Faculty of Mathematics and Science of State University of Makassar. The design of this study (Table 1) was pretest-posttest non-equivalent control group design[29]. This study was conducted in three classes, all of which were Basic Biology classes. The samples of the study were students who possess homogenous initial academic ability based on grouping test. Before treated, an essay test developed by the researcher was given to the three classes to measure the students' meta cognitive skill.

Table 1. The Design of Quasi-Experimental Study

Pretest	Group	Posttest
T_1	X_1	T_2
T_3	X_2	T_4
T_5	X_3	T_6

Where,
T_1, T_3, dan T_5: Pretest
T_2, T_4, dan T_6: Posttest
X_1: PBL-RQA Strategy
X_2: PBL Strategy
X_3: RQA Strategy

The instruments of the study were validates before used. The three classes experienced three different learning strategies for about 1 semester, and in the end of the study a post test was given to them.

3. Results and Discussion

The result of the anacova test of the students' meta cognitive skill is presented in Table 2, and the result of the Least Significance Different test is presented in Table 3.

Table 2. The Result of the Anacova Test of the Students' Meta cognitive Skill

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13674.160[a]	3	4558.053	29.592	.000
Intercept	62123.431	1	62123.431	403.315	.000
XMetacogSkill	6897.435	1	6897.435	44.779	.000
Strategy	4985.599	2	2492.799	16.184	.000
Error	15711.264	102	154.032		
Total	295623.867	106			
Corrected Total	29385.424	105			

Table 3. The Result of the Least Significance Different test of the Effect of Learning Strategy on the Students' Meta cognitive Skill

Strategy	PreMeta	Postmeta	Gaining	MetaCor	LSD Notation
RQA	7.389	39.855	32.465	43.484	a
PBL	14.965	50.390	35.425	47.002	a
PBL-RQA	11.350	59.535	48.185	59.496	b

Based on Table 2, it can be seen that learning strategies affect the students' meta cognitive skill ($p <$ sigma 0.05). Based on Table 3, it can be seen that the meta cognitive skill mean score of the students experiencing PBL-RQA learning strategy is 21% significantly higher than those experiencing PBL learning strategy and 26.9% higher than those experiencing RQA learning strategy. There is no difference of students' meta cognitive skill between those experiencing PBL learning strategy and RQA learning strategy.

Based on the study results, it reveals that the students' meta cognitive skill can be improved through PBL-RQA learning strategy better than through PBL and RQA learning strategies. It means that the potential of PBL in empowering students' meta cognitive skill can be enhanced by combining it with RQA learning strategy.

The integration of RQA learning strategy and PBL learning strategy is conducted to overcome the weaknesses of PBL learning strategy and optimize the empowerment of meta cognitive skill through PBL syntax. PBL and RQA learning strategies combined in PBL-RQA learning strategy aims to develop self-regulated learning so that students can be responsible to manage and control their self-learning. Moreover, it also helps students to be independent and self-regulated learners. Self-regulated learner can be trained through particular strategies or efforts. Therefore, PBL-RQA strategy can be implemented to empowering meta cognition skill which then improves students' concept understanding.

The improvement of students' meta cognitive skill taught by PBL-RQA strategy is closely related to PBL stages. Through PBL stages, students are confronted with real problems which are ill-structured. In this case, students will do anything to make the problems clearer and well-structured. Students might also make several possible hypotheses and problem solving based on information from written resources. Students' activities during the implementation of PBL stages obviously activated their meta cognition skill. The activities related to PBL stages are used as the basic measurement that there is meta cognition activity in PBL strategy[30]. Similarly[11], reported that PBL had potential to activate meta cognitive skill. PBL improves meta cognitive self-regulation[10] and fosters thinking and learning process. In[30] found that PBL fastened the development of university students' meta cognition.

The PBL stages within PBL-RQA strategy encourage students to participate and face various problem-solving in a small group work during the learning process[31]. In this strategy, problem is first step in collecting and integrating new knowledge[32] as well as facilitates students to learn by solving real and authentic problems also integrating interdisciplinary knowledge[33]. In[34] stated that one of key purposes of PBL learning stages is to guide students' self-development to be able to recognize their own need to study, determine self-purpose of study, define relevant questions to study, access relevant information, and test deep understanding related to the information learnt[35].

PBL stages within PBL-RQA strategy aim at constructing wide and flexible basic knowledge, developing effective problem-solving skill, and performing as an effective collaborator as well as intrinsic motivation to study[36]. In[37] also stated the objectives of PBL as to create students to be able to perform process skill and problem solving skill as well as long life learning. Long life learning is an ability to conduct self-learning, find information, learn collaboratively, and think reflectively.

Through PBL strategy, students might perceive that they are involved in the real life situation rather than theoretical concept[38].

Beside the existence of PBL stages within PBL-RQA strategy, the optimization of activation of students' meta cognitive skill also depends heavily on RQA stages within PBL-RQA strategy.

This causes the meta cognitive skill of students taught by PBL-RQA improves better and higher than the meta cognitive skill of students who only experienced PBL or RQA strategy. In[9] study on animal physiology course, as well as[39] study on genetic course reported that RQA learning strategy is able to activate students' meta cognitive skill. In addition, RQA strategy can develop students' inquiry and thinking ability, and increase group work motivation and communication among groups. Furthermore, Sumampouw[39] suggested that the learning characteristics of this strategy are potential to empower students' high order thinking skill. Theoretically, every learning having meta cognitive characteristics is believed be related to students' thinking ability. Learning structure of the RQA strategy shows learning patterns requiring students to read, raise questions, and provide answers independently based on written materials. The developed learning patterns show that the learning focuses on students' active participation.

The improvement of students' meta cognitive skill taught by PBL-RQA learning strategy is closely related to the role of RQA learning syntax consisting of assigning students to: a) Raise problems in form of written questions related to a certain topic or subtopic, b) Answer their questions in written form, c) Present the questions and answers in both group discussion and class discussion. By considering the RQA learning syntax, we could see that this learning strategy was very potential to empower students' meta cognitive skill (12). In order to find problems, one should be meticulously read relevant materials first to catch the main idea. After that, based on the main idea one is able to provide questions, and, of course, is able to find the solutions. From the learning activity, students can conduct self-assessing, in which they might understand what they knew before by the reading activity. All of the process related to RQA learning syntax requires students to always perform high order thinking skill act.

PBL-RQA strategy gives students opportunity to experience self-regulated learning which encourages them to be discipline and enables them to find more evidences related to a particular topic, such as being forced to read a particular topic known as RQA stages, so that they can gain various issues from different sources. During PBL-RQA learning, students are fostered to learn independently, sort irrelevant information while focussing on the crucial ones, work in group, solve problems, and learn how to apply problem concepts. These learning activities help students to absorb more information and make them to be more responsible to their learning.

The reading activity done by students within PBL-RQA strategy shows the meta cognitive learning and is effective to improve the students' outcomes during the learning activities. This strategy facilitates them to improve their meta cognitive skill. It is stated previously that the advantages of RQA strategy within PBL-RQA strategy is emphasized on reading, summarizing, raising questions, and providing answers. In[40] research result as mentioned by[41] showed that the difference of reading strategy was correlated to the purpose of reading. It was also stated by Anderson[42] that deciding whether reading texts selectively or wholly, and separating the relevant information out of the irrelevant one, should be based on the purpose of reading.

Specifically, a stage to raise problems in form of questions within PBL-RQA strategy is a part of empowerment of students' meta cognitive skill. Similarly, Slavin[8] found that students' mastery might be better when they are taught to question themselves. According to[8], inquiry strategy can empower meta cognitive skill[43], and it can be classified as a meta cognitive strategy depends on the objective of inquiring[5]. Within RQA learning, students were given an opportunity to conduct independent learning by solving individual assignment, namely creating questions. Questioning skill is a part of meta cognitive skill. Furthermore, one of alternatives to enhance students' thinking ability was by delivering questions that might activate their thinking process. Questioning is a common learning technique and is fundamental to high quality of learning[44]. In addition,

questioning might ignite students thinking process and one of the important utility of questioning is to ignite high order thinking skill.

In discussed Piaget's statement[45] that questions enable students to think creatively. Question is useful in many ways, such as motivates students, helps students to think in orderly, helps students to finds interest as well as expresses feeling, and develops thinking skill, and alike[46].

Questions raised by students could be used by lecturer to check their understanding, and to enhance their thinking process. In[47] stated that questions can be used to stimulate students' ability in stating opinion. In stated that the easiest way to challenge creative and critical thinking was through questioning. Therefore, in order to reconstruct students' thinking skill, lecturers should guide them to be a skilful questioner. An ability to find problems followed by delivering them in form of questions is an important aspect in learning activity which aims at improving students' thinking skill. Lecturers need to guide students to raise questions that can stimulate their reasoning.

Regarding the RQA learning syntax within PBL-RQA strategy, it is seen that one of it's steps is students be able to summarize the reading materials and to conduct the discussion. Such activities show meta cognitive learning pattern. It is in line with Malone & Mastropieri's statement that summarizing is one of learning strategy that empowers students' meta cognitive skill[48,49]. This potential is believed to be greater since summarizing is done in the end of the implementation of PBL-RQA strategy.

Students applying this strategy in their learning activities might also show better meta cognitive skill. In explained that meta cognitive skill helped students to be self-regulated learners who were responsible to their own learning improvement and to adapt their learning strategy achieving the learning objectives[1]. Meta cognitive training could be taught either separately or inserted deliberately in a particular learning.

In relation to the effort to empower the students' meta cognitive skills, it is clearly seen that this effort was done deliberately through the implementation of meta cognitive strategy in student-centered learning strategies. The meta cognitive strategy integrated to PBL-RQA learning stages either depends on or does not depend on the learning content. As it is explained that the empowering of meta cognitive skill can be both integrated to a particular course and also can be independent from the learning content.

The meta cognitive strategy mentioned above is in form of self-assessing method. The PBL-RQA learning syntax developed shows that the students' activities is started from reading texts, then students think of problems found and create questions. Furthermore, students discuss the relevant assignment given to clarify the unclear answers or solutions. In the end, the students experience self-assessing activity to monitor their thinking process and their learning outcomes.

PBL-RQA learning that shows meta cognitive training strategy pattern is proven to be able to improve students' meta cognitive skill. This finding verifies a study by Kuiper[50], also implementing self-regulated meta cognitive strategy to facilitate students to reconstruct their meta cognitive skill. Daley[51] and Peters[52] also claimed how constructivist learning emphasizing on self-reflection and knowledge construction played an important role in meta cognitive skill.

PBL-RQA strategy involving three key components explaining the most appropriate comprehension strategy to be used, when, where, and how to use the strategy as well as a self-regulated learner practice within the implementation of the strategy confirms clearly the existence of meta cognitive learning pattern. It is reflected when students conducted a discussion in order to clarify any things. Based on the discussion activity, students know what they did not know before. Thus, students might be able to develop themselves to be self-regulated learners.

PBL-RQA learning enables students to practice self-assessing activity by rechecking every things known or misunderstanding related to the known concept, and every things unknown and how to stimulate the obtained knowledge after lecturers do clarification in the end of the learning. When students start to master the meta cognitive strategy as well as learn when, why, and how to implement the meta cognitive strategy, they will be able to learn more effectively and intensively[53]. This is in line with River's[54] and research report that students who are able to conduct self-assessment are mostly aware of their own capability, act more strategically and better, compared to those who cannot do self-assessment[55].

Another advantage of the implementation of PBL-RQA strategy is to activate cooperative work to do peer teaching (share skills, experiences, and induce understanding by clarifying solutions). RQA potential to empower students' meta cognitive skill theoretically was higher when the implementation of the learning syntax was conducted in group.

The integration of RQA and PBL learning strategy containing cooperative activity proves the RQA learning

potential. As it is already commonly known generally cooperative learning has potential to empower students' meta cognitive skill[56]. In[57] stated that the learning carried out in cooperative way aimed at activating students' willingness to share their skills and experiences possessed before, or to construct a new meaning.

The collaborative learning within PBL-RQA enriches the self-recognizing process by creating an interrelated environment between individual and society, between individual and ideas, as well as between individual and a self-learning process. In stated that collaborative learning such as PBL-RQA provides a mean to creation and self-definition[58]. This is in line with Savin-Baden's[59] statement saying that learning through PBL strategy (within PBL-RQA strategy) might challenge students' self-confidence, and their way to see world and act accordingly. It is considered appropriate in encouraging students to reconstruct their own knowledge, and to make self-decision on the relevant learning, as well and to recognize their capability, interest, and purpose of learning. Students might tend to understand their own self-awareness and, thus, they will be better in evaluating themselves. Therefore, students might identify their strengths and weaknesses as well as the means to solve and correct their mistakes[34].

By empowering meta cognitive skill during the implementation of PBL-RQA learning, it is expected that it will bring positive impact on the development of students' cognitive aspects. As it is claimed by[52] that meta cognitive skill is useful to make students to be self regulated learners, since it encourages them to be self-manager and to judge their own thinking and learning. Therefore, teachers need to implement learning strategies which not only emphasize to the cognitive development but more than that, the meta cognitive skills are also important to be empowered during learning process.

4. Conclusion

Based on the study findings and its' discussion, it can be concluded that the potential of PBL strategy in empowering students' meta cognitive skill can be improved by integrating RQA learning strategy. The students' meta cognitive skill mean taught by PBL-RQA strategy is 21% higher than that of PBL strategy and 26.9% higher than that of RQA strategy.

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