PBLRQA model to the development of metacognitive awareness in pre-service teachers

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ABSTRACT

Metacognition is one of the key learning skills in the 21st century, with a strong potential to help students succeed in science learning. Until now, this metacognitive awareness is less empowered by lecturers in learning. This study aimed to analyze the problem-based learning (PBL) reading-questioning-answering (PBLRQA) model's effect on metacognitive awareness in pre-service teachers. This research is a quasi-experiment with a pretest-posttest nonequivalent control group design. Determination of the research sample class was carried out by random sampling. Each learning model was represented by PBLRQA and PBL class. The number of classes used was 2, totaling 57 students. The instrument used was the metacognitive awareness inventory (MAI). This inventory comprised 52 statement items divided into planning, monitoring, evaluating, and revising skills. An important finding in this research is that students' metacognitive awareness in learning with PBL and PBLRQA is not significantly different. Thus, the PBLRQA and PBL models can still be used in students' science learning to encourage metacognitive awareness, so that academic success can be achieved.

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1. INTRODUCTION

Educational researchers have shown that metacognition improves academic achievement [1]. It is because metacognitive awareness is important in success and failure in achieving learning goals [2]. In addition, metacognition is a component for self-directed learners in assessing abilities and challenges while learning and monitoring and regulating students' actions to achieve learning goals [3]. Metacognition includes metacognitive strategies (e.g., planning, monitoring, and evaluating) and metacognitive knowledge related to strategies, tasks, and oneself [4]. Metacognitive processes are a sequence of higher skills used to regulate cognitive, emotional, and motivational strategies during learning [3], [5]. In addition, metacognitive awareness is a person's awareness related to self-learning, including understanding the object being studied, learning strategies that are carried out, and how to self-evaluate [6]. Metacognition refers to the experience of mental awareness, i.e., feelings, thoughts, and awareness [7]. Various studies make strong claims for the importance of metacognition in student learning. Metacognition contributes about 17% to students' success in school, while intelligence contributes about 10% [3]. This significant statistic, clearly shows the need for schools to teach metacognitive awareness effectively [8].

According to Flavell [9] metacognition is likened to a machine that triggers a person's learning and thinking awareness. It involves recognizing and monitoring one's own cognitive activities and activities as needed. Metacognition consists of knowledge of cognition and regulation of cognition. Knowledge of cognition is a person's awareness of his knowledge, for example, related to tasks or another knowledge. There are at least three forms of knowledge that need to be known, namely declarative, procedural, and conditional knowledge. Regulation of cognition is interpreted as a person's way/strategy to control his cognitive processes, for example, strategies related to planning, monitoring, and evaluation [10]. Someone who has high metacognitive awareness is predicted to have a great opportunity to achieve academic success [11]. Metacognitive awareness becomes an internal force that encourages someone to plan, monitor, and evaluate their learning. So, without help from other people, including teachers and parents, students are independent in managing their learning process. Thus, metacognitive awareness in science learning is the key to becoming an autonomy learner and academic success [12].

Developing metacognitive awareness is an alternative to support students' academic success. Strong metacognitive awareness in students triggers them to learn. Students become more sensitive to listening to messages from within themselves to position themselves for learning tasks. Normally developed metacognition helps students to master concepts and determine appropriate strategies for learning. Metacognition allows students to become more skilled in thinking and more effective and efficient in their learning. When working together in small groups, students can also stimulate each other's metacognition resulting in better results [13]. Metacognitive awareness has developed and been recognized in the last 50 years because it is considered to make a positive contribution to student learning achievement [14]. For example, students with stronger metacognitive awareness learn more and perform better than their metacognitively weak peers [15].

Metacognitive awareness has a strong potential to help students succeed in science learning [12], [16]. Students with strong metacognitive awareness know how to choose and apply learning strategies and can solve problems to be successful in their studies [17]. Students can also evaluate the effectiveness of their strategies as their overall plan and use their evaluations to plan for future learning [18]. These awareness can positively impact learning and achievement, but many students come to college without strong metacognitive awareness [19]. To help biological science undergraduates develop these skills, lecturers must understand how students' metacognition may change in college [20]. One way this can be done is by comparing the use of metacognitive regulation skills in junior and senior science students [21]. The knowledge gained from this comparison can then be used to help students improve their use of metsacognition early in their college careers. Students demonstrate metacognitive knowledge when distinguishing between concepts they know and those they do not know [13].

Pre-service science teachers need factual, contextual, procedural, and even metacognitive knowledge and apply this knowledge, attitudes, and science products to their daily lives [22]. Feedback is important in developing a scientifically accurate understanding of complex science concepts, leading to improved learning. It is because it provides students with information about what they have done well and what still needs improvement [23]. Unfortunately, it is difficult for lecturers in science classrooms to provide enough feedback and direction to help students learn [24]. To balance this factor, innovative strategies must be implemented to provide feedback on students' learning needs [25].

Students with higher metacognitive awareness can more easily understand concepts and use various relevant strategies for learning [26]. Metacognitive awareness is a trigger for implementing the strategy as well as for modifying the chosen approach [27]. Metacognitive awareness can greatly influence learning. So, prospective elementary school teachers can implement this strategy [28]. One way that can be done to achieve this goal is to determine when, why, and how students develop best to use this ability. Teachers can use insights from students who are particularly good at metacognition to help other students increase their metacognitive awareness [29].

Research shows that in science learning, 25% of teachers do not make enough efforts to empower students' metacognitive skills [30]. One way to improve this is by learning actively, and creatively, and having patterns such as problem-based learning (PBL). PBL has the opportunity to increase the metacognitive awareness of pre-service science teachers. So far, students' low metacognitive awareness is caused by students' lack of attention in problem-solving. One important aspect of the problem-solving process is metacognitive awareness [31]. It can be predicted that students' metacognitive abilities are directly proportional to their problem-solving skills [32]. In addition, PBL has been proven to improve creative thinking and critical thinking skills [33], as well as problem-solving skills [34], and writing skills [35]. PBL can also increase students' self-confidence, create an environment that supports group work, improve interpersonal communication, and build self-awareness [36], [37]. PBL is still considered important for students in constructing knowledge, scientific reasoning, and increasing intrinsic and external learning [38].

In addition, reading, questioning, and answering (RQA) is proven from the three models used in learning to have the strongest influence on improving students' metacognition [39]. Research by Bahri [40] found that implementation of the problem-based learning reading-questioning-answering (PBLRQA) model helps in improving metacognitive skills and learning outcomes that contribute to student retention. Applying the RQA model is proven to motivate students to read the assigned learning material. Thus, the designed learning can be implemented well, and understanding of the learning material can increase to close to 100%. In addition, RQA can improve students' critical thinking skills and metacognition [41]. RQA can also increase conceptual knowledge (40.57), questions (34.91), and student's understanding of the learning material [41], [42]. Therefore, both PBL and RQA models are considered appropriate to be applied in learning strategies with a constructivist approach. These two models are not only based on the skill of memorizing concepts or facts but the process of interaction between students and their learning environment [43]. PBLRQA can be used in developing students' future life skills. PBLRQA can be applied in schools because it is problem-based, involves problem-solving thinking activities, and correlates with students' abilities. PBLRQA increases learning motivation, potentially empowering metacognitive skills and improving student retention [44].

Based on the facts presented in the background of this study, there are not many studies investigating the contribution of metacognitive awareness with the PBLRQA model. The results of research so far show that the PBLRQA model can improve metacognition skills [45], [46], learning outcomes and student motivation [47], besides increasing the cognitive retention of students [48], critical thinking [49], creativity [50]. However, PBLRQA in facilitating metacognitive awareness for science students has not been explored. Applying the right learning model helps teachers identify the contribution of metacognitive skills in the learning process in the classroom. Thus, this study aimed to analyze the effect of the PBLRQA model on the metacognitive awareness of pre-service teachers.

2. RESEARCH METHOD

2.1. Research design

This research is a quasi-experiment with a pretest-posttest nonequivalent control group design [51]. The independent variable in this research is the learning model, which consists of 2 levels, namely PBL and PBLRQA. The dependent variable in this research is metacognitive awareness. Metacognitive awareness measurements were carried out before and after treatment by applying the learning model to both PBL and PBLRQA treatment groups.

2.2. Population and sample of research

In this study, the population consisted of pre-service elementary school teachers who were in semester VII and who offered science practicum learning. They are spread into three classes A, B, and C. Determining the research sample class was carried out by random sampling. Each learning model is represented by one class as the PBLRQA group and another class as the PBL group. So, there are 57 students.

2.3. Research instrument

The instrument applied was a metacognitive awareness questionnaire. The metacognitive awareness questionnaire was adapted from the metacognitive awareness inventory (MAI) [52]. This inventory consists of 52 statement items divided into knowledge of cognition 17 items and regulation of cognition 35 items. Knowledge of cognition consists of declarative knowledge of 8 items, procedural knowledge of 4 items, and conditional knowledge of 5 items. Regulation of cognition consists of planning 7 items, comprehension monitoring 7 items, information management strategies 10 items, debugging strategies 5 items, and evaluation 6 items. In addition, a student response questionnaire was also given to the implementation of the PBLRQA and PBL.

2.4. Research procedure

This research aims to compare the effects of PBL and PBLRQA learning models on the metacognitive awareness of pre-service elementary school teachers. So, to obtain data that suitable in accuracy and consistency are needed in data collection. The core data in this research is metacognitive awareness. The research data was collected through the following activities: i) Giving a metacognitive awareness questionnaire to determine awareness before and after learning in the research classes; ii) Observing the lesson plan implementation by using the observation sheet and giving a checklist (√) on the appropriate statement; iii) Giving a questionnaire of student responses to each lecture in a class that uses the PBLRQA and PBL.

2.5. Data analysis

The research data were analyzed with parametric statistics. Inferential statistical data analysis through covariate analysis (ANCOVA) was carried out if necessary for hypothesis testing. Before testing the hypothesis, metacognitive awareness data in the PBL and PBLRQA learning model treatment groups must meet the requirements for normality and homogeneity. The dependent variable data, namely metacognitive awareness, which was initially on an ordinal scale, was transformed into intervals. In data analysis with ANCOVA, the metacognitive awareness pretest was used as a covariate.

3. RESULTS AND DISCUSSION

Metacognitive awareness data were obtained before and after the treatment of the implementation of the PBLRQA and PBL learning models in the treatment group. The mean pretest data for metacognitive awareness in the two treatments is 62.15 and 83.60, indicating that the mean pretest for learning with PBLRQA is 21.45 points higher than PBL.The mean metacognitive awareness after learning with PBL and PBLRQA increased to 65.08 and 92.02. So, the mean posttest learning with PBLRQA is 26.94 points higher than PBL. Hence it is concluded that PBLRQA is better at increasing metacognitive awareness compared to PBL. Information about students' metacognitive awareness in science practicum learning is shown in Figures 1 and 2. Notes: declarative knowledge (DK), procedural knowledge (PK), conditional knowledge (CK), planning (P), comprehension monitoring (CM), information management strategies (IMS), debugging strategies (DB), and evaluation (E).

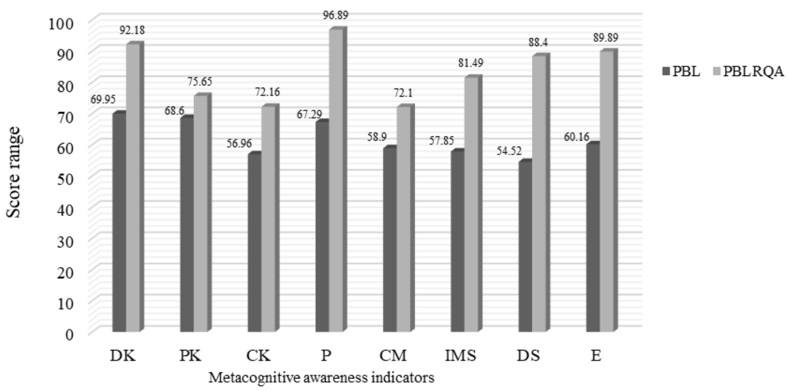

Figure 1. Graph of students' metacognitive awareness before treatment

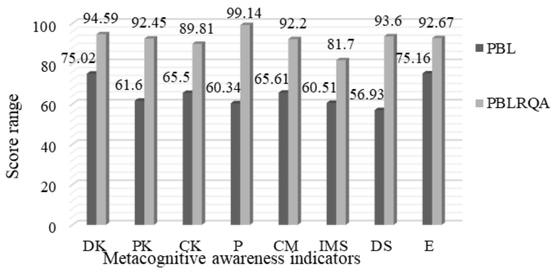

Figure 2. Graph of students' metacognitive awareness after treatment

In Figures 1 and 2, we can see that the most prominent element of metacognitive awareness is planning. Before and after learning with PBL, the element of metacognitive awareness that students lack the most is debugging strategies. It is different with PBLRQA before learning, the elements that students lack are conditional knowledge and comprehension monitoring, and after learning with PBLRQA the elements that students still lack are information management strategies.

In the research results section, the research results are described concerning the results of statistical analysis tests. This study aimed to examine the effect of the PBLRQA model on metacognitive awareness in science practicum concepts. As an important part of hypothesis testing, the prerequisite test consists of normality and homogeneity tests. Normality and homogeneity using residual data. The normality test results of metacognitive awareness data in learning using PBL and PBLRQA using unstandardized residual values with linear regression followed by Kolmogorov Smirnov Test and Shapiro Wilk respectively 0.200 and 0.071.

The data homogeneity test was analyzed using Levene's test using residual data with the assistance of SPSS programme, where the significant value is 0.376. So, metacognitive awareness variables are greater than alpha (0.05), meaning the data is declared homogeneous. The results of the prerequisite analysis show that the data meets the requirements for hypothesis testing. Hypothesis testing was conducted using ANCOVA with the assistance of SPSS 16.00. The metacognition awareness test using the metacognitive awareness questionnaire was conducted twice. The first time was done before the treatment was given, and the second time was done after the treatment ended, with the period for the pretest and posttest. The ANCOVA results is shown in Table 1. Table 1 shows that there is no significant difference in metacognitive awareness between the PBLRQA and PBL treatments by controlling for students' pretest metacognitive awareness $[F(1.54) = 0.345, p = 0.559, \eta p2 = 0.006]$.

Table 1. ANCOVA test results of the effect of learning model on metacognitive awareness

Source	Type III sum of squares	df	Mean ssquare	F	Sig.	Partial eta squared
Corrected model	1100.717[a]	2	550.358	7.076	0.002	0.208
Intercept	4080.112	1	4080.112	52.456	0.000	0.493
MA_PRETES	1068.662	1	1068.662	13.739	0.000	0.203
Model	26.848	1	26.848	0.345	0.559	0.006
Error	4200.171	54	77.781	-	-	-
Total	252220.064	57	-	-	-	-
Corrected total	5300.888	56	-	-	-	-

R squared = 0.208 (Adjusted R squared = 0.178), Dependent variable: MA_POSTTES

The results show that the PBL and PBLRQA has the same potential to increase metacognitive awareness. The PBLRQA has the potential to trigger metacognitive awareness. This learning model helps students organize themselves in learning, for example, planning, implementing, and evaluating their learning [53]. PBL and PBLRQA syntax have the same goal, namely developing independent learning or self-regulated learning so that students can organize, supervise and control their learning (self-regulated). The PBL stage of learning with PBLRQA and PBL provides opportunities for students in groups to study problems, understand, and think of the best ideas as solutions. In RQA, there is a reading phase where students can use various information or learning materials prepared by the lecturer. Reading is a complex learning activity. Students usually try to achieve reading comprehension. Therefore, metacognitive awareness is needed to encourage students to understand their reading. In this case, students can use strategies such as underlining, finding keywords, and looking for new vocabulary. So, awareness of these activities or tasks is a form of metacognitive awareness that was followed by implementing various strategies. The success of students in completing reading challenges maybe changes students' self-concept about reading, that reading is useful and a fun activity [54].

In addition, students can add or search for similar information or supporting information in reading to compare or analyze the various truths of the information. Another important phase of RQA learning is questioning. In this phase, students formulate questions as a form of planning in learning, but it also helps encourage metacognitive awareness [40]. Questioning is a student's attempt to express curiosity and express intelligence about something that requires further explanation. Formulating good questions is a creative act and the essence of science. Questioning is a thinking process skill structurally embedded in thinking and problem-solving [53]. Even though students have the ability to ask questions, this shows their great potential in obtaining new information and clarifying knowledge. Therefore, the opportunity to ask questions needs to be utilized well. This may happen because students do not want to always draw attention to themselves or because the teacher's role is to always motivate students to ask questions. Additionally, only a portion of students can respond directly by raising their finger to ask a question as a form of expression of good cognition. Generally, the questions asked demonstrate factual and procedural knowledge and are closed-ended [54].

Learning with PBLRQA contains four characteristics: i) student awareness to apply with high commitment and consistency, ii) learning practices that prioritize optimizing critical thinking skills so that they can be identified, assessed, and inferred, iii) problems formulation in a specific context relevant to students' needs, and iv) metacognition aspect, to guide students to know what they should have [55], [56]. Besides RQA, PBL also has the potential to increase metacognitive awareness. PBL is the most innovative learning model that stimulates students, where structured or authentic problems are presented to students to embed the learning process by building new knowledge into solving the problem [57], [58]. Studies show that PBL not only increases metacognitive awareness in learning but also critical thinking skills, students' academic achievement, and enables them to communicate in group discussions and build their knowledge compared to conventional learning models [59]. Other results show that PBL increases student engagement by fostering group work skills that stimulate cooperation and mutual analysis by enabling knowledge, information sharing, and discussion [60], [61].

Metacognitive awareness can be managed to trigger the development of metacognitive skills. This skill guarantees the organization of learning as seen from students planning, monitoring, and evaluating the learning process periodically and continuously. Students are aware that they have to struggle to achieve their goals, acquire new knowledge that did not exist before by using several strategies, and understand the learning process they are experiencing. By doing so, students can find out whether the learning process has reached their goals [60]. Metacognitive awareness is one of the key competencies in the learning process in the 21st century because it can generate good ideas and solutions in the learning process [61]. Lecturers as designers should be able to design or design all learning activities well so that students also feel challenged in encouraging critical and innovative thinking in learning. Still, the most important thing is awareness in understanding learning so that they can make planning, action, smonitoring, and evaluation to repeat the same learning cycle. Thus, occasionally, there must be improvements and increases in metacognitive in solving problems and making the best decisions.

4. CONCLUSION

Based on the results of the research and discussion that has been done, it can be concluded that the learning model does not affect students' metacognitive awareness. The PBLRQA and PBL models both have the same opportunities for prospective students' metacognitive awareness. Several suggestions can be made related to the findings of this study, including: i) for lecturers, the findings reveal that the PBLRQA and PBL model has the potential to empower metacognitive awareness so that it is suitable to be applied to learning at the college level as well as at other levels; ii) It is necessary to disseminate information on the findings of this study by introducing the PBLRQA and PBL learning models because they are proven effective in increasing students' metacognitive awareness. It is also necessary to explore the metacognitive awareness of students, especially students who have learning problems that it is known how they overcome these difficulties and their impact on academic achievement. An exploration of teacher and student metacognitive awareness has been carried out, as well as its application to learning includes planning, monitoring, and evaluating.

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