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Development and Validation of Learning Strategy for Metacognitive Skills Empowerment: PBLRQA (PBL integrated with Reading, Questioning, and Answering)

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Abstract. Traditional learning strategies were still dominated the pattern of lectures at the Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Indonesia. This strategy was not optimal to empower metacognitive skills of students. Problem Based Learning (PBL) is a constructivist learning strategy that could potentially in empowering metacognitive skills. The implementation of PBL has revealed various benefits, but there was also some weakness. Thus, it required a learning strategy, which is expected to cover that weakness of PBL as Questioning, Reading, and Answering (RQA) learning strategy. RQA is a learning strategy developed based on the fact that almost all students do not read the upcoming lecture materials, causing failure of learning strategy planned and finally the students' comprehension becomes low. Integration PBL and RQA is called PBLRQA learning strategy. This research was a research and development (R & D). This article reports the development and validation of the PBLRQA strategy. The research using 4D model (Define, Design, Develop, and Dissemination). The result of research showed that this learning strategy and its learning instrument to be a valid strategy and learning instrument of metacognitive skills empowerment. Teacher can use this strategy in other lectures and consider with the learning material characteristics.

1. Introduction

During this time, the lectures of Animal Physiology in Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Negeri Makassar, Indonesia, tend to focus on cognitive learning outcomes and have not yet empowered the students' metacognitive skills. This implies the cognitive abilities of students who tend to be low because they have not been trained to be self-regulated learners. Metacognition skills can be empowered through learning strategies.

It takes a learning strategy that is capable to empower metacognitive skills. According to reference [1], empowerment of metacognitive skills was important to make students become independent learners. By the empowerment of metacognitive skills, students can manage their own learning and can improve their learning outcomes. There was a relationship between metacognitive skills and students' cognitive learning outcomes [2] and student retention [3,4].

Problem-based Learning Strategy (PBL) is considered appropriate to empower students' metacognitive skills. PBL is based on learning not only the process of memorizing concepts or facts, but the process of interaction between students and their environment. PBL could develop higher-

order thinking skills such as metacognitive skills [5,6], critical thinking, self-learning, and cooperative skills [7]. PBL involved thinking activity to solve the problems, and correlated with the cognitive function of learners [8].

The implementation of PBL reveals various benefits, but there are also some weaknesses in this learning strategy. The use of PBL required more time, more material, and made the student should seek more information [9], not all students could be involved [10], lack of curriculum and textbook guidance containing various example problem [11]. It could make the students or even teachers having difficulty to raise the problem. Students also have difficulty to solve problems due to lack of prior knowledge of students related topics covered due to lack of interest in reading students.

Another learning strategy is Reading, Questioning, and Answering (RQA), a strategy developed based on of the fact that students did not read the course material, which resulted in a lecture strategy that is designed to be difficult to accomplish and ultimately the understanding of lecture material becomes low. Reference [1] argued that the implementation of RQA proved to be able to force the students to read the course material, so that the lecture strategy designed can be done and the understanding of the lecture material has been improved. The reference [12] also found that students' metacognition could be improved through the RQA strategy. With the improvement of metacognitive skills, is expected to improve student cognitive learning outcomes.

The integration of the RQA syntax into the PBL (PBLRQA), is expected to complement and overcome the weakness of each strategy and also to maximize their potential to empower students' metacognitive skills. Based on the above rationality, it is deemed necessary to develop a PBLRQA strategy in Animal Physiology lectures to empower metacognitive skills of students.

2. Experimental Details

This research was a Research and Development using the development of instructional design 4 D model [13]. Research stages include define, design, and develop of PBLRQA strategy and instructional tools of Animal Physiology course. The disseminate is planned to be carried out on large-scale testing (experimentation). Once developed, PBLRQA learning strategies and instructional tools in the form of semester course plan and evaluation instruments in the form of an essay test were validated by two experts and then revised. In addition to validated by experts, evaluation instruments were tested on the students of Department of Biology, FMIPA UNM, Indonesia.

3. Results and Discussion

3.1. Define

The purpose of this stage is to define the requirements of learning with the analysis of the objectives of the material constraints at beginning. This stage includes: First, front-end analysis aimed to establish the basic problems faced in the course. The results of analysis showed that the Animal Physiology course was dominated by learning that is still oriented to mastery of concepts and tends to ignore the empowerment of metacognitive skills. Second, the results of student analysis indicated that the heterogeneous student academic ability of students with high academic ability, moderate, and low. Third, task analysis includes content structure analysis and procedural analysis. The learning outcome of this course includes aspects of knowledge, attitude, general skills, and special skills. Fourth, material analysis involves the formulation of learning objectives and the identification of the learning material.

3.2. Design

This stage aimed to produce the design of strategies and learning tools. At this stage the PBLRQA syntax was designed. In design of learning tools consists of: (a) design of learning syntax, (b) selection of the semester course plan format, (c) initial design of the semester course plan, (d) preparation of an essay test to measure students' metacognitive skills (e) design of observation sheet, (f) design of

metacognitive skill rubrics, and (g) design of cognitive rubric. The result of this stage was prototype strategy and lecture tool.

3.3. Develop

This stage produced a revised syntax of PBLRQA and the instructional tools based on the suggestions from the experts. The semester course plan is a planning program developed as a guideline for lecturing for every learning process activity. Components include learning objectives, learning materials, learning strategies and methods, learning steps, learning resources, and assessment. This stage is generated a valid learning device that will be used in experimental research.

3.3.1. PBLRQA Strategy and learning instrument

The learning strategy was the PBLRQA strategy, which is the integration of Problem-based Learning (PBL) strategy with Reading, Questioning, and Answering (RQA). Instructional tools developed were: (a) semester course plan, (b) an essay test instrument for measuring metacognitive skills and measuring students' cognitive abilities (c) metacognitive skill rubrics, and (d) cognitive rubrics. Implementation of learning strategies PBLRQA refers to the learning components such as the application of syntax, social systems, reaction principles, support systems, instructional and accompanist impact.

3.3.1.1 Learning syntax of PBLRQA

The lecture syntax developed in this study was the syntax of learning strategy that integrates the PBL syntax with RQA learning syntax, hereinafter referred to as PBLRQA strategy. Characteristics of PBL and RQA syntax allow both to be integrated into a new learning strategy. The PBLRQA learning strategy has six steps, as shown in Table 1.

Table 1. Syntax of PBLRQA strategy.

Phase	Teaching Activity
Orientation of students to the problem, and directs students to read the literature	Explain the purpose of learning, logistics required, learning topics, and directs students to read literature, motivating the students to engage in problem-solving selected
Students make questions over the reading material and related issues	Assign students to submit problems related reading material in the form of questions and then answer the questions that have been created
Organizing students to learn	Organize students to learn according to the group that has been formed
Guiding investigations in groups and discuss the answers and questions that have been made	Guiding group discussion
Develop and submit work through group presentations	Helping students plan and prepare appropriate work such as reports, videos, and models as well as helping them to share tasks with friends
Analyze and evaluate the problem-solving process	Helping learners to reflect or evaluation of their investigation and the processes they use

3.3.1.2 Social system

The social system explains the relationship between students, teachers, and the environment, so that these systems are expected to contribute to each other to implement the PBLRQA learning strategy.

3.3.1.3 Principle of reaction

The reaction principle relates to the ability of the lecturer to respond to questions, answers, or other activities undertaken by the student. The lecturer's role in PBLRQA strategy as a facilitator that

provides a number of activities to stimulate student curiosity, encourages students to explore ideas and communicate them scientifically, as mediators that help students connect their learning resources as motivators that motivate students to develop their learning interests, as a moderator that directs learning activities.

3.3.1.4 Supporting system

Implementation of PBLRQA strategy requires instructional tools in which there are semester course plan and evaluation instruments, and others supporting tools.

3.3.1.5 Instructional and accompanist impact

Instructional impact of metacognitive skills trained to students on every step of learning. From this learning strategy it is expected that the students can make their learning meaningful through the experiences given by the lecturer or from the students' own experience. Accompanist impact in terms of improvement of learning outcomes that are directly achieved by directing students to the expected learning objectives.

3.3.2. Validation Results of PBLRQA Strategy

The PBLRQA strategy developed has been further validated by two experts. The validation results are shown in Table 2.

Table 2. Validation result of PBLRQA strategy appropriateness.

No	Aspect	Validator			
		Val. 1	Val. 2	Average	Category
1	Purposes	4	4	4	SV
2	Supporting Theory	4	3.5	3.75	SV
3	Learning Syntax	3.9	3.8	3.85	SV
4	Social System	3.5	3.5	3.5	V
5	Principle of Reaction	4	4	4	SV
6	Supporting System	4	4	4	SV
7	Instructional and Accompanist Impact	3.67	4	3.84	SV
8	General Conclusion of Validation	4	3.5	3.75	SV
	Average			3.84	SV

Notes: V: Valid, SV: Strongly Valid

Table 2 shows that the PBLRQA strategy, in terms of objectives, supporting theories, learning syntax, social systems, reaction principles, support systems, instructional impacts, and accompanist impact, can be categorized as strongly valid with a mean validity of 3.84.

3.3.3. Validation Result of Instructional Tools

The semester course plan referring to the PBLRQA strategy developed has been further validated by two experts. The validation results are shown in Table 3.

Table 3. Validation result of semester course plan.

No	Indicator	Validator			
		Val. 1	Val. 2	Average	Category
1.	Identity	4	4	4	SV
2	Learning outcome (Cognitive, Affective, and Psychomotoric)	3	4	3.5	V
3	Basic competence	4	4	4	SV
4	Course Material	3.6	3.4	3.5	V
5	Learning Activity	3.75	3.75	3.75	SV
6	Leaning Experience	4	3	3.5	V

7	Assessment and Evaluation	4	3	3.5	V
8	Time Allocation	4	4	4	SV
9	Reference for Students Worksheet	4	3	3.5	V
	Average			3.69	SV

Notes: V: Valid, SV: Strongly Valid

Table 3 shows that the semester course plan, reviewed from a variety of validity indicators, can be categorized as strongly valid with validity rating was 3.69. Assessment tools in the form of integrated essay tests to measure metacognitive skills and cognitive ability of students who have been developed subsequently validated by two experts. The validation results are shown in Table 4.

Table 4. Validation result of test instrument.

No	Indicator	Validator			
		1	2	Average	Category
1.	Learning Material	4	3.75	3.88	SV
2	Rubric	4	4	4	SV
3	Construc	3.67	4	3.84	SV
4	Language	3.75	3.5	3.63	SV
	Average			3.84	SV

Notes: VV: Strongly Valid

Table 4 shows that the essay test instrument to measure students' metacognitive skills, viewed from the material aspect, rubrics, constructs, and language, is categorized as strongly valid with a validity rating was 3.84.

The results showed that PBLRQA strategy and instructional tools were declared valid and feasible to be used. Learning strategies that integrate PBL and RQA form a PBLRQA strategy will complement each other and optimize their potential to empower the metacognitive skills. The syntax of PBL and RQA in this strategy has the same goal of developing self-directed learning so that students can be responsible for organizing and controlling their own learning (self-regulated). According to reference [1], self-regulated learning could be empowered or trained through specific strategies or efforts. Therefore the PBLRQA strategy has the opportunity to empower metacognitive skills that ultimately enhance students' conceptual understanding.

The potential of PBLRQA strategy in improving metacognitive skills is inseparable from the PBL stages in this strategy. Through the PBL stages, students are faced with an ill-structured real-world problem and the student seeks to make the problem a well-structured one. Students will formulate several possible hypotheses and solutions based on information from various sources of reading. The activities of learners that occurred during the PBL implementation clearly involved metacognition [5,6,14]. PBL enhanced self-regulation [15] and leads to a process of thinking and learning.

The PBL stages of the PBLRQA strategy allow students to participate, and deal with problem-solving situations in small group work during the learning process [16]. In this strategy, problems were the first step in collecting and integrating new knowledge and facilitating students to learn through real-world problem solving [17], and authenticity as well as integrating interdisciplinary knowledge [18]. The main purpose of PBL was to guide students' self-development to be skilled in terms of recognizing the need to learn, setting their own learning goals, defining relevant questions to learn, accessing relevant information, testing in-depth understanding of what has been learned [19,20]. Reference [21] mentioned that the purpose of PBL was to make learners proficient in process skills and problem-solving skills and lifelong learning which is an independent learning skill.

In addition, optimizing the empowerment of students' metacognitive skills in PBLRQA strategies is also inseparable from the RQA stages. Reference [22] reported that the RQA learning strategy proved to empower students' metacognitive skills. Reference [6] explained that students must first carefully read related material, to capture the main meaning. Furthermore, on the basis of the main meaning that

has been captured, then the learners are ready to prepare the questions that contain the problem, and of course also easy to formulate the answer. From reading activities, students can do self- assessing, where students will understand what has been known from reading activities that have been done. All the processes that the learners are living related to the RQA syntax is certainly "forced" them to get used to thinking high level.

More specifically, the stages of raising problems in terms of questions on PBLRQA strategy are part of empowering students' metacognitive skills. Question is the trigger of the student's thinking process. Reference [6] suggested that questioning skills were part of metacognitive skills. Furthermore, reference [6] explained that one of the alternative improvement of students' thinking ability was by asking questions that can stimulate the thinking process. Correspondingly, reference [23] found that student mastery was better if they are taught to ask themselves. Reference [23,24] suggested that questioning strategies have the effect to empower metacognitive skills, and inquiring could be classified as a metacognitive strategy depending on the purpose of asking.

In line, reference [25] said that questions could help students think coherently and develop the thinking skills. Reference [26,27] suggested that the questions posed by learners could be used by lecturers to check students 'understanding, and to improve students' thinking processes. Reference [28] explained that the easiest way to challenge creative and critical thinking was with questions. Therefore, in an effort to improve students' thinking skills, lecturers should direct students to be skilled questioners.

The last step of PBLRQA is making summary. This kind of learning activity shows metacognitive learning patterns. This is in line with the statement that summarizing was one of the learning strategies that can empower the metacognitive skills of learners [6,29]. This potential is believed to be even greater because the summarizing task is carried out at the end of the PBLRQA.

In this PBLRQA, students are trained to conduct self-assessing by matching what is known or misconceptions of known concepts, what is not yet known and how to empower the knowledge that has been obtained after the lecturer to clarify at the end of the learning. When students begin to master metacognitive strategies and learn when, how, and why to use them, they are able to learn more effectively and intensively. This is in line with reference [30] reported that skilled learners make an assessment of themselves aware of their abilities, acting more strategically and better than the unskilled.

PBLRQA demonstrating the metacognitive strategy training pattern has been proven to improve students' metacognitive skills. The findings of this study are in accordance with the results of the reference [31] study using a metacognitive self-regulated learning strategy to help learners improve their metacognitive skills. Thus, PBLRQA stages help students to develop thinking skills and make students be self-regulated learner.

Another benefit of implementing the PBLRQA strategy is to train cooperative learning to share the skills, experience and understanding they are induced through the principle of clarifying the answers. Reference [6] argued that the potential of RQA to empower students' metacognitive skills theoretically gets bigger, when the implementation of the learning syntax takes place in groups. Reference [32] stated that cooperative learning in general had the potential to empower metacognitive skills.

Through empowerment of metacognitive skills during learning with PBLRQA strategy, it is expected to have a positive impact on the development of cognitive aspects of students. This is in line with reference [33] stated that metacognitive skills encouraged students to become their own upper-class managers and become assessors of their own thinking and learning. The syntax integration of PBL strategies with RQA syntax will complement and reinforce each other. Teachers need to apply learning strategies that not only emphasize cognitive development but more metacognitive aspects are also important to be empowered during learning process.

4. Conclusion

Based on the above explanation, it can be concluded that PBLRQA learning strategies and lecture tools that have been developed meet the valid criteria. However, it is necessary the practically and

effectiveness testing in experimental research to prove the potential of integration of PBL and RQA into PBLRQA strategies to empower students' metacognitive skills.

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References
[1] CorebimaA D 2009 *Jadikan peserta didik pebelajar mandiri (Making students be self-regulated learner)* (Indonesia: Paper presented on National Seminar at Universitas Negeri Makassar)
[2] Bahri A 2016 Exploring the correlation between metacognitive skills and retention of students in different learning strategies in biology classroom (Indonesia: Proceedings of 2ndICMSTEA: International Conference on Mathematics, Science, Technology, Education, and their Applications 3rd – 4th October) pp156-162
[3] Bahri A and Corebima A D2015 The contribution of learning motivation and metacognitive skill on cognitive learning outcome of students within different learning strategies (*Journal of Baltic Science Education vol 14)* pp 487-500
[4] Palennari M 2016 Exploring the correlation between metacognition and cognitive retention of students using some biology teaching strategies (*Journal of Baltic Science Education vol 15*) pp 617-629
[5] Akcay B 2009 Problem-Based learning in science education (*Journal of Turkish Science Education vol 6*) pp 26 -36
[6] Corebima A D 2010 Berdayakan keterampilan berpikir selama pembelajaran sains demi masa depan kita (Thinking skills empowerment during science lesson for our future)(Indonesia: Proceedings of Science National Seminar, Universitas Negeri Surabaya)
[7] Steck TR DiBiase W Wang C and Boukhtiarov A 2012 The use of open-ended pbl scenarios in an interdisciplinary biotechnology class: evaluation of a pblcourse across three years (*Journal of Microbiology & Biology Education vol13*) pp 2-10
[8] Izzaty R E 2006 Problem-based learning dalam pembelajaran di perguruan tinggi (PBL in high education) (Paradigmavol1) 77–83
[9] Akinoglu O and Tandogan R O 2007 The effects of problem-based active learning in science education on students' academic achievement, attitude and concept learning (*Eurasia Journal of Mathematics, Science & Technology Education3*) pp 71-81
[10] Treagust D F and Peterson R F1998 Learning to teach primary science through problem-based learning (Science Educationvol 82) pp 215-237
[11] Ward J Dand Lee C L2002A review of problem-based learning (*Journal of Family and Consumer Sciences Education vol20*) pp16-26
[12] Corebima A D and Bahri 2011 A Reading, Questioning, and Answering (RQA): A new learning strategy to enhance student metacognitive skill and concept gaining (Singapura: Paper presented at International Symposium at Nanyang Technology University)
[13] Thiaragajan S,SemmelD S andSemmel M L 1974 Instructional Development for Training Teachers of Exceptional Children (Minnesota: Indiana University)
[14] Downing K, Kwong T, Chan S W, Lam T F and Downing W K2009PBL and development of metacognition (High Education Journalvol 57)pp 609–621
[15] Sungur S and Tekkaya C 2006 Effect of problem-based learning and traditional instruction on self-regulated learning (*The Journal of Educational Research vol 99*) pp307-317.
[16] Yuan H, Kunaviktikul W, Klunklin A and Williams B A 2008 Promoting critical thinking skills through PBL (*Journal of Social Science and Humanities vol 2*) pp85-100.
[17] Barrows H S 1996Problem-based learning in medicine and beyond: a brief overview. In L. Wilderson and W.H. Gijselaers (eds.) Bringing Problem-based Learning to Higher Education: Theory and Practice. New Directions for Teaching and Learning. No.68 (San

Francisco: Jossey-Bass)
[18] Keziah AA2010 A comparative study of problem-based and lecture-based learning in secondary school students' motivation to learn science (*International Journal of Science and Technology Education Researchvol1*) pp126–131
[19] Savin-Baden M and MajorC H 2004Foundations of problem-based learning(Open University Press: Buckingham)
[20] Blumberg P 2000Evaluating the evidence that problem-based learners are self-directed learners: a review of the literature. In Problem-Based Learning: A Research Perspective on Learning Interactions (*New Jersey: Lawrence Erlbaum Associates*)pp 199-226
[21] Tan O S 2004 Cognition, metacognition, and problem-based learning. In Tan, OonSeng (Ed). Enhancing Thinking through Problem Based Learning Approaches (Singapure: Thomson)
[22] Sumampouw H M 2011Keterampilan metakognitif dan berpikir tingkat tinggi dalam pembelajaran Genetika (Artikulasi konsep dan verifikasi empiris) [Metacognitive skills and high order thinking skills in Genetic (Concept articulation and empirical verification)](*Jurnal Bioedukasi*vol 4)pp 23-39
[23] SlavinR E 2000Educational Psychology(Boston: Allyn and Bacon)
[24] Schraw G and Dennison R S1994Assessing metacognitive awareness (Contemporary Educational Psychology vol 19) pp 460-475
[25] Martin R 1997Teaching science for all children. Sec. ed. (Allyn and Bacon: Boston)
[26] Pasch M, Sparks-Langer G, Gardner T G, Starko J and Moody C D 1991 Teaching as decision-making: instructional practices for the successful educator (Longman Publishing Group: New York)
[27] Frazee B M and Rudnitski R A 1995Integrated teaching methods: theory, classroom applications, and field-based connections (Delmar Pub: Albany)
[28] Mahanal S, Zubaidah S, Bahri A and Dinnurriya M S 2016 *Improving Students' Critical Thinking Skills through Remap NHT in Biology Classroom (Asia-Pacific Forum on Science Learning and Teaching vol 17)*
[29] Malone L D and Mastropieri M A 1992 Reading comprehension instruction: summarization and self-monitoring training for student with learning disabilities (*Exceptional Childrenvol 58*) pp 270-279
[30] Rivers W P 2001 Autonomy at all costs: an ethnography of metacognitive self-assessment and self-management among experienced language learners (*The Moderns Language Journal* vol 86) pp 279-290
[31] Kuiper R 2002Enhancing metacognition through the reflective use of self-regulated learning strategies (*Journal of Continuing Education in Nursing33*)pp 278-287
[32] Johnson D W and Johnson R T 1999Learning together and alone: cooperative, competitive, and individualistic learning (5th ed.) (Boston: Allyn& Bacon)
[33] Peters M 2000 Does constructivist epistemology have a place in nurse education (Journal of Nursi*ng Education*vol 39) pp 166-170