

Open Inquiry with Learning Journal Promoting Metacognitive Skills and Retention of Students with Low Academic Achievements

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Abstract—The expected skill to face the 21st century is the level of thinking that involves high order thinking concept known as metacognition, which is also believed as a notable predictor on retention. The purpose of this study is to investigate the effect of open inquiry model combined with a learning journal on metacognitive skills and retention of students with low and high learning achievement levels. This study was quasi-experimental research, using the equivalent post-test only with control group design. The subjects of the experiment comprised 60 eleventh grade students. The samples were randomly assigned in a 2 x 2 factorial design. Two learning models were compared: open inquiry and conventional models, and two learning achievement: high and low. The metacognitive skills and retention of students were measured by an essay test integrated with achievement test. The result of a 2-way ANOVA test confirmed that open inquiry with learning journal has a significant effect on metacognitive skills and retention of students with different learning achievement levels. Open inquiry with learning journal appears to be an effective strategy among students with high and low learning achievement levels.

Keywords—metacognitive skills, retention, open inquiry, learning journal, and learning achievement

I. INTRODUCTION

An expected thinking skill to face the present era is the level of thinking about the thinking process, which implicates Higher-Order Thinking known as metacognition [1]. Higher-order thinking includes creative thinking, critical thinking, and problem-solving covering the combination of deep understanding of specific topics, proficiency of using basic cognitive process effectively and behavioral control [2]. Therefore, in order to improve higher-order thinking, we need to empower metacognitive skills. Moore [3] has been indicated that metacognitive skills are highly related to planning skills, monitoring skills, and evaluation skills. These skills are important to be owned by learners in order to help them to be a self-regulated learner, which responsible for their own learning progress and learning strategies on any required task. Furthermore, metacognitive skills are also believed to play an important role in many types of cognitive activity including comprehension, communication, attention, memory, and problem solving [4]. These skills related to the memory capacity of each individual where the one can release his/her skills based on the experiences that his/her still remember. This term is known as retention. Theoretically, metacognition has

believed to have a correlation with student retention. Retention was the ability to remember the subject matter until a specified period was the same as the material being taught [5]. Remembering is taking or understanding the necessary information of our memory for a long time period. Koffka (1965) in Olson and Hergenbahn [6] explained that memory process was the activity in the brain caused by environmental experience when the process stops, and the effect is still lagging behind traces in the brain. Therefore, the importance of metacognitive skills and retention as a notable prowess that students should possess to face the educational advancement in this era, both of them need to be empowered together in the process of learning including biology subject.

In fact, the learning involvement process of various educational levels in Sulawesi Island, Indonesia still emphasizes to focus on the cognitive aspect. The pattern is constantly dominated by teacher-centered learning paradigm and non-constructivism so that the effectiveness and construction of the learning process are in a deficient condition. The empowerment potential learners' has not been implemented maximally that induces the learning process to become meaningless. These situations point all students to attend all of the learning activity at the school, which is not attractive to them. This habit is also believed to produce more passive learners where students lack the ability to manage their brains or control their learning processes. In addition, the teacher-centered approach has been recognized as an incapable approach to developing various skills of students including metacognitive skills. This fact shows that the students have adversity with arranging and gauging their thinking advancement. This fettle is being a notable thing that should be, as the metacognitive skills are a strong predictor of students' cognitive development. However, metacognitive skills are a simple strategy; it is powerful to improve the students' thinking and learning abilities. Additionally, The metacognitive skills encompass various aspects including memory monitoring, self-regulation, and awareness that are being the notable aspects in developing a quality of learners.

An application of inquiry-based learning becomes one of an expected method to develop various abilities and skills. The use of inquiry-based learning can help pre and in-service teachers to implement constructivism in their own teaching activity [7]. However, there are many kinds of inquiry levels including structure inquiry, guided inquiry

and open inquiry based on how much information provided. In Indonesia, both guided inquiry and open inquiry are the recommended inquiry level in curriculum 2013, yet the application of those both methods should consider the situation of students and schools. A study on the comparison between guided inquiry and open inquiry [8] found that open inquiry involves more high-order thinking and a deeper understanding of performing science. In open inquiry, students make their own decisions throughout each stage of the inquiry process so that they will study independently as well as improve metacognitive skills in the learning process.

Another situation is that all students are not in the same basic knowledge specifically the learning achievement levels. Seikkula-Leino [9] categorized the learning achievement level of pupils to underachievers and achievers, which are determined as high and low learning achievement level. However, the students in low learning achievement dominantly have poor oral communication ability. This situation also becomes a problem on improving students' learning performances, as the real feedback or reflection of learners is an important consideration regarding the success of learning. The use of a learning journal in reflecting students learning is a significant manner. The students in low learning achievement will independently reflect themselves through the writing process. The prospect is that the students can write their experiences without the pressure that will produce more memorable learning. Besides that, the students with high academic ability can obtain a significant involvement through the process of open inquiry learning, which is appropriate for them. According to this study tried to investigate the effect of open inquiry with learning journal on the metacognitive skills and retention of students with different learning achievement levels. This study also concerned about the effect of interaction between teaching models and learning achievement levels on metacognitive skills and retention of students. The expectation was that open inquiry supported by a learning journal would provide a significant improvement on metacognitive skills and retention of students in both high and low learning achievement levels

II. METHOD AND DESIGN

The sample consisted of 60 science students in grade 11th State senior high school 14 of Makassar, South Sulawesi Indonesia. All students were in 16 to 17 years old group to high and low levels of learning achievement. Students with high learning achievement (n=30) and low learning achievement (n=30) were placed in experiment class (15: high & 15: low) and control class (15: high & 15: low). The study was quasi-experimental research, using the equivalent post-test only with control group design. The students were randomly assigned on the condition of a 2 x 2 factorial design (Table 1), where one factor was the provision of open inquiry (high and low learning achievement levels) and another factor was a provision of the conventional method (high and low learning achievement levels).

TABLE I. RESEARCH BLUEPRINT OF FACTORIAL EXPERIMENT 2 X 2

Academic ability	Method (S)	
	Open Inquiry (E)	Conventional (C)
High (H)	EH (n: 15)	CH (n: 15)
Low (L)	EL (n: 15)	CL (n: 15)

EH: High learning achievement in the experiment group

EL: Low learning achievement in the experiment group

CH: High learning achievement in the control group

CL: Low learning achievement in the control group

The experiment was conducted on the eleventh-grade students studying in State Senior High School 14 of Makassar, South Sulawesi Indonesia. The treatment was seven periods of biology learning excluding post-test. The first step was grouping. The second phase was the validation process by five experts who have implicated their consideration in developing all instruments of this study. The third step was a treatment process in which the researcher was as a teacher. The third step was post-test and retest. The last step was data analysis. The instrument of metacognitive skills and retention in this study was essayed test integrated with achievement test. The essay questions used in examining metacognitive skills referred to cognitive levels of C2 to C5 from Bloom's taxonomy revised by Anderson & Krathwohl. The essay test was applied supported by a specific rubric as the scoring process using 0 to 7 rating scales designed to measure metacognitive skills developed by [10]. In addition, the retention of students was collected through the retest score after three week periods from posttest.

A 2-way ANOVA test was carried out to analyze the data of this study. Statistical analysis was assisted with the software SPSS 20 for Windows; it was applied to the significant extent of 0.05 ($p < 0.05$). The advanced test was executed by the Least Significant Difference test (LSD). Before conducting a hypothesis test by using 2-way ANOVA, the assumption test includes its homogeneity and normality test of data was examined.

III. RESULT AND DISCUSSION

The result of the study describes the students' metacognitive skills and retention through variance analysis (2-Way ANOVA). The score of metacognitive skills is obtained from the post-test score, while the score of retention is obtained from the different deviation between post-test and re-test after 3-week learning periods.

TABLE II. THE SCORE OF METACOGNITIVE SKILLS AND RETENTION IN EACH LEVEL OF STUDENTS

Learning achievement/ Teaching model	Metacognitive skills		Retention	
	High	Low	High	Low
Open inquiry + learning journal	68.80	46.93	4.80	5.66
Conventional model	45.13	22.60	7.4	8.8

Table 2 Shows that: 1) in low learning achievement groups, the mean post-test score of the students in an open inquiry class was 99.69 % higher than the mean post-test score of students in the conventional class. 2). In high learning achievement groups, the mean post-test score of the

students in open inquiry class was 46,60 % higher than the mean post-test score of students in conventional classes. Below is the result of a 2-way ANOVA test.

A. Metacognitive skills

TABLE III. THE SUMMARY OF THE ANOVA TEST OF METACOGNITIVE SKILLS

Source	Mean Square	F	Sig.
Teaching model	8640.000	1078.395	.000
Learning achievement	7392.600	922.702	.000
Learning achievement * teaching model	1.667	.208	.650

The F score of teaching model is 1078.395 with p-value $0.000 < \alpha (0.05)$. Hence, H_0 can be rejected, and H_a is accepted. This means that teaching model had a significant effect on the students' metacognitive skills.

The ANOVA test showed that the group, which was carried out by using open inquiry learning, has a higher mean than the group treated using conventional methods. This study indicated that the metacognitive skills of students taught using open inquiry were 72.72 % higher than students treated using the conventional model. In addition, the data analysis also showed that students with high learning achievement had a higher mean score than those students with low learning achievement in both experiment and control groups. The interaction between the teaching model and learning achievement level also indicated no significant effect on the metacognitive skills of students. However the present study includes four groups, so it was necessary to apply the Least Significant Difference (LSD) test.

TABLE IV. THE SUMMARY OF LSD TEST ON METACOGNITIVE SKILLS

No	Group	Mean	Std. DV	Notation
1	Open inquiry-high	68.80	1.320	a
2	Open inquiry-low	46.93	3.239	b
3	Conventional-high	45.13	3.673	c
4	Conventional-low	22.60	4.256	D

The result of LSD showed that 1) the students' metacognitive skills in conventional –low learning achievement group were the lowest scoring of the four groups. 2) The students' metacognitive skills in open inquiry-high learning achievement group were significantly the highest scoring among the other interactions. The metacognitive skills of students in conventional-high learning achievement group were 99.60% higher than conventional-low learning achievement group. While the metacognitive skill score in the open inquiry-high learning achievement group was 46.60% higher than the open inquiry-low learning achievement group. In addition, there is no significant difference between students with low learning achievement level in open inquiry and students with high learning achievement level in the conventional model.

B. Retention

The description of retention was in the form of a mean score of the different deviation between post-test and the second test (re-test) after three week periods based on teaching model and learning achievement levels of students.

The result of the 2-way ANOVA test of retention is described below.

TABLE V. THE RESULT OF THE ANOVA TEST OF RETENTION

Source	Mean Square	F	Sig.
Teaching model	123.267	12.695	.001
Learning achievement	19.267	1.984	.164
Learning achievement * teaching model	1.067	.110	.742

The F score of teaching model was 12.695 with p-value $0.001 < \alpha (0.05)$. Hence, H_0 can be rejected, and H_a is accepted. It means that teaching model had a significant effect on the students' retention. In addition, ANOVA test showed that the mean score of the different deviation between post-test and the second test after three-week periods indicated the retention of students taught using open inquiry were 54.78 % higher than those students treated using conventional model. Another result showed that there was no significant difference in retention between students with high and low learning achievement levels. Those both high and low groups of students obtained almost in an equal score. The interaction between the teaching model and learning achievement level also performed no significant effect on student retention. However the present study includes four groups, so it was necessary to apply the Least Significant Difference (LSD) test.

TABLE VI. THE SUMMARY OF LSD TEST ON RETENTION

No	Group	Mean	Std. DV	Notation
1	Open inquiry - High	4.80	2.203	a
2	Open inquiry - Low	5.66	2.077	b
3	Conventional - High	7.40	2.229	c
4	Conventional - Low	8.80	3.277	d

The result of LSD test showed that 1) the retention of students in conventional –low learning achievement group was the highest scoring of the four groups, 2) The student retention in open inquiry-high learning achievement group was significantly the lowest scoring among the other interactions, 3) There was no significant difference in students' retention between low and high learning achievement groups in experiment class, and 4) There was no significant difference in students' retention between low and high learning achievement groups in the control class.

Open inquiry encouraged students who were independently involved in biology learning activities, and its steps had covered the aspects of metacognitive skills. The process of determining the problems, creating a core problem, making a hypothesis, and planning the problem solving or experiment design were determined as the planning aspect in metacognitive skills. The monitoring aspect in metacognitive skills includes an experiment, observing, collecting as well as analyzing during the learning process. The last activity is to provide inferential learning as evaluation aspect in metacognitive skills. In open inquiry phases, The knowledge has been obtained through self-investigation using the scientific method, so the students gained the evident information directly related to their everyday life that was acquired from the learning process in the school. Students searched and determined their own concept from the problem analysis, clarified the

correctness and evaluate their work to produce more understanding that will be saved in their mind for a long time.

There are four aspects of metacognitive skills were involved through open inquiry model. Firstly, in the planning phase, students explore their understanding to find out their previous knowledge, which will help them in completing assignments, they know managing the plan to complete the task and set the time during planning activity. Secondly, in open inquiry phase, the students were working on the metacognitive skill sheets, which push them to use their prior knowledge. Students ask themselves about the information they need to know and how much time they need the questions given to solve the problem. Thirdly, in monitoring phases, the students move to solve the problems that they have listed, remember the important information, and verify their work. Throughout, the students in monitoring activity, they will ask her/himself related to the important information that should be remembered and the activity they should do to complete their work or solve their problem. Fourthly, in the evaluation phase, the students will do an inspection on the suitability between their knowledge and the way to solve the problem. They can reflect themselves on how well they have worked on learning. In addition, inquiry-based learning involved students in more direct learning that gave the most impact on the materials that they have been learned. As a consequence, they can save those materials in their mind for a long time period. Bahri [11] indicated that an application inquiry-based learning in biology subject significantly intensified the metacognitive skills of students. Moreover, Zion and Mendelovici [8] also mentioned that open inquiry imitates and reflects the experimental work and research implemented by a scientist. It empowers high order thinking capability that covers a variety of skills including metacognitive skills.

Another result was that there was no significant effect on the interaction between learning achievement levels and teaching model toward students' metacognitive skills and retention. The LSD test of metacognitive skills showed no significant difference between students with low learning achievement level treated using open inquiry and students with high learning achievement level treated using the conventional model. This situation indicates that students with low learning achievement in open inquiry class gained a suited improvement with those high-level students in the conventional class. In addition, the different score between low and high groups in open inquiry class was only 46.60%, while the difference between low and high groups in the conventional class was 99.60%. Students with low learning achievement level in open inquiry class tried to minimize the different distance score with those high-level students. According to van Rossum and Schenk [12] that the interaction between learning strategy and academic achievement levels is believed to minimize the different distance of learning score in both high and low ability students.

The open inquiry class facilitated learning journal for students with low learning achievement level that helped them empowering metacognitive strategy in every period of learning. An application of learning journal in this study has reduced the failure of students' as self-reflection in which those students who were not able to evaluate or reflect their

learning orally will be able to write it clearly. In a conventional class, the real competition was indivertible. Both high and low-level students tried to get a higher result. While indeed, the progress of both high and low ability students performed using the conventional model was not significantly improved. The prior study by Setiawan and Susilo [13] supported these findings that there was metacognitive skill improvement through writing learning journal, which is one of the methods that can improve student ability in writing and self-reflection in the learning process. Writing learning journals are a powerful learning tool [14]. Learning journal might be seen as an accentuation of the right conditions of learning [15]. Additionally, the character of group work or cooperation in open inquiry learning was the potential to facilitate scaffolding. The scaffolding process in this open inquiry was through peer tutorial, which demands students to study by mutual learning. The students with high learning achievement level who already mastered more basic knowledge gave assistance to those who have less knowledge about the subject or topic of learning. This peer assistance activity has motivated the students with low learning achievement level to process their zone proximal development. In consequence, those low-level students tried to equalize their skills with those students with high learning achievement level. This indication is in line with Welch, Klopfer [16] who found that open inquiry is not only for bright kids but also for all levels of students.

In addition, The LSD test of retention also indicated no significant difference between students with low and high learning achievement levels in both experiment and conventional classes. This output defines that students in both high and low learning achievement levels were able to remember the materials that have been taught through open inquiry with learning journal model. In that, open inquiry model in this study provided various problems connected to daily life issue integrated with learning material in biology. This process is not only re-issuing what has been saved but also how to use it in a certain situation to solve the problem. The open inquiry also contains more senses in the process of thinking that develop more meaningful learning. This indication may influence the reinforcement of students' retention on the concept that they have learned.

The students in the low group have experienced more direct learning that offers a significant impact on the learning materials, so they can strongly save and remember what they have gained. Moreover, almost all activities in open inquiry-based learning were performed through students' idea and thinking, so that might become the incentive factor to keep their understanding in their mind. This point appeared on both low and high students' learning achievement groups so that those both high and low level of students performed an equal result of retention. The previous studies have supported these indications. For instances, the involvement of students solves the problems related to their daily life will be easier to save on their memory and then employs it if facing identical problems in another situation [17]. Antika, Corebima [18] concluded that providing problems and more active learner in the process of learning intensified the meaningfulness of learning process, so it becomes the notable things to increase the number of materials that will be remembered in a long period of time.

In addition, during the learning process, if the students have an opportunity to observe the object directly, the concepts would be saved in their memory for a long time [19]. The one who gains and manages learning material to understand clearly will reduce the forgetfulness, and the material will be saved on the long-term memory of students [5]. On the other hand, Students in both low and high learning achievement levels obtained a similar failure in retention through conventional method. Students in both low and high levels were not able to save their material in their long-term memory. The conventional model contained less involvement and feedback in its activity. The process of learning directed students to become more passive, as they gained knowledge without its usefulness and its relation to daily life. Tinto [20] has supported this finding that in order to improve student retention, there are some aspects should be considered namely expectation, support, feedback, involvement, and learning, so that students in low and high learning achievement levels are able to line up their retention, if all of those aspects are conducted in the learning activity. In addition, more active student-centered learning with problem giving would intensify the means of the learning process that effects the incensement of long-term student memory [21]. This situation happens to all levels of students.

IV. CONCLUSION

The findings offer the following conclusion: 1) the open inquiry learning with learning journal is more potential to facilitate metacognitive skills and retention of students with both high and low learning achievement levels. 2) The general interaction between teaching model and learning achievement showed no significant difference in metacognitive skills and retention of students. Accordingly, open inquiry with a learning journal appears to be affective on students with different learning achievement.

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