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The Impact of Assessment in Jigsaw Cooperative Learning Method and Logical Thinking Ability on Biology Achievement by Controlling Students' Prior Knowledge

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ABSTRAK

Guru biologi khususnya guru SMP harus mampu memilih metode pengajaran yang tepat agar bahan ajar yang dikomunikasikan dapat dipahami secara konkrit dan formal. Penelitian ini bertujuan untuk menganalisis pengaruh penilaian menggunakan metode pembelajaran kooperatif tipe Jigsaw dan kemampuan berpikir logis terhadap prestasi belajar Biologi setelah dilakukan pengendalian pengetahuan awal siswa. Penelitian ini dilakukan dengan desain treatment level 2 x 2. Melalui random sampling, ditentukan 84 siswa sebagai sampel. Semua pengujian yang diperlukan dari Ancova dua arah telah dipenuhi. Hasil analisis data dengan Ancova dua arah, setelah dilakukan pengendalian pengetahuan awal siswa menunjukkan bahwa prestasi belajar biologi siswa yang mengikuti penilaian kinerja lebih baik dibandingkan siswa yang mengikuti penilaian tertulis pada metode pembelajaran kooperatif tipe Jigsaw; terdapat pengaruh interaksi antara penilaian metode pembelajaran kooperatif tipe Jigsaw dan kemampuan berpikir logis terhadap prestasi belajar biologi siswa; bagi siswa yang mempunyai kemampuan berpikir logis tinggi lebih cocok mengikuti penilaian kinerja pada metode pembelajaran kooperatif tipe Jigsaw; dan pada kelompok siswa yang mempunyai kemampuan berpikir logis rendah lebih cocok mengikuti penilaian tertulis dalam metode pembelajaran kooperatif tipe Jigsaw. Berdasarkan kesimpulan penelitian ini, disarankan kepada guru biologi agar jenis penilaian yang diterapkan dalam metode pembelajaran, berpikir logis, hasil belajar biologi, dan pengetahuan awal siswa harus menjadi pertimbangan dalam melakukan proses pembelajaran.

ABSTRACT

Biology teachers, particularly junior high teachers should be able to select appropriate teaching methods thus teaching materials that are communicated can be understood concretely and formally. This study aims to analyze the effect of assessment using jigsaw cooperative learning method and logical thinking ability on Biology achievement after controlling students' prior knowledge. This study was conducted with design treatment by level 2 x 2. Through random sampling, it was decided 84 students as sample. All of requisite testing from two-way Ancova was fulfilled. The result of data analyzed with two-way Ancova, after controlling students' prior knowledge showed that the students achievement in biology who took performance assessment was better than the students who took written assessments in cooperative learning method using jigsaw type; there was an interaction effect between assessment in cooperative learning method of jigsaw type and logical thinking ability toward the students achievement in biology; for those students who had high logical thinking ability were more compatible to take part in performance assessment in cooperative learning method using jigsaw type; and for the group of students who had lower logical thinking ability were more compatible to take written assessment in cooperative learning method of jigsaw type. Based on the conclusion of this study, it is suggested to biology teachers that the type of assessment applied in learning method, logical thinking, biology learning outcomes, and students' prior knowledge should be taken into consideration in conducting learning process.

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1. INTRODUCTION

Problems dealing with the low achievement in the subject of Science in National Examination (NE) among junior high school students have been an implicated issue in the world of education. This is in line with Giri that principally stated that the average score of NE for Science among students in several schools in Bali is obviously low in the recent five years, for example, in the case occurred in SMP Negeri 1 Seririt. This matter has been our common responsibility to strive for the achievement in science thus it can be improved in the future. From the average achievement obtained in science, it can be seen the capabilities of our human resource in the field of science and technology. It would be possible that in the future, our human resources will not be able to compete at the national as well as international levels particularly in the area of science and technology in order to deal with all the demands in the era of globalization (Dasor, 2019; Djabba, 2020; Wati, 2019). When traced profoundly about the learning process implemented by science teachers in junior high schools, there are numbers of unpredictable factors causing the low achievement of Science in National Examination. Several factors which were identified as the causes of the low achievement of Science among the junior high school students included: in applying teaching approach(es), teachers mostly focused on the matters; the type of assessment applied in teaching method was less appropriate; conventional teaching methods were mostly applied; teachers were reluctant to adopt a constructivist model of teaching; teachers were unwilling to use relevant and standardized literatures; before the teaching and learning process began, there was no actualizing concepts; most of the laboratory equipments did not meet the standards; and the students were not optimally trained to think critically according to the logical rules (Forawi, 2016; Martaida et al., 2017). In the process of Biology teaching and learning, teachers not only convey the abstract concepts of biology, but also include the concrete or actual concepts of it. In order to be able to master the concepts of Biology as a whole, it is necessary to understand both concrete and formal concepts. Based on this statement, then Biology teachers, particularly junior high teachers should be able to select appropriate teaching methods thus teaching materials that are communicated can be understood concretely and formally. In accordance with understanding concrete and abstract concepts in an assessment, performance assessment is suitable to be applied in jigsaw of cooperative teaching methods (Utami et al., 2021; Yudiastika, 2017). According to previous research, performance assessment is a system used to consider the improvement of the quality of students' assignments given (Bong & Park, 2020; Grivokostopoulou et al., 2017). The performance tasks require (1) the application of important science concepts and that supports information; (2) the importance of working habits for study or scientific search; and (3) demonstration of scientific literacy.

One of the logic roles is to develop intellect and logical thinking skills thoroughly and independently. A person's intellect is associated with intelligence. Therefore, if logical thinking is part of logic, it can be concluded that logical thinking skill is also associated with intelligence (Handayani, 2013; Sobur, 2015). This is relevant to that proposed by previous research, that one of the internal factors affecting the ability to do the test and affecting the results of learning in the subjects of Biology is the factor of intelligence, particularly logical thinking skills (Ambarita, 2020; Sucipta et al., 2023). Likewise, the findings of similar research, it was stated that those students given insertion of logical thinking in the biology learning process achieved higher learning outcomes than those who were not (Forawi, 2016; Martaida et al., 2017). This findings was also supported by the findings of similar research, which essentially stated that: (1) students taught Biology using the methods of empirical-inductive learning cycle achieved higher learning outcomes compared with those students who were taught using conventional methods, for students that had high logical thinking skills; and (2) students taught Biology using the methods of empirical-inductive learning cycle achieved less learning outcomes when compared with those students who were taught using conventional methods, for students who have low logical thinking ability (Mayasari & Adawiyah, 2015; Sirait et al., 2022). In addition to the assessment in cooperative learning method and logical thinking skills, student learning outcomes are also influenced by prior knowledge of the students. Prior knowledge refers to the concepts that have been possessed by the students before carrying out the teaching material process which acts as an initial regulator that directs students to the material learnt. Students' prior knowledge can be a concrete concept gained through observation and can also be an abstract concept, which is obtained from reading the corresponding books. This prior knowledge is very influential on student learning outcomes. In other words, the levels of students' prior knowledge toward the teaching materials that will be delivered by a teacher greatly affect students' learning outcomes. In accordance with Biology learning outcomes, students' prior knowledge greatly affects the outcome of learning Biology.

2. METHOD

This research was conducted at SMP Negeri 1 and SMP Negeri 2 Seririt Seririt. Through random sampling, it was obtained that students from grade VIII class A4 and class A3 as experimental groups, and those students from grade VIII class A2 and class A5 as the controlling groups. After obtaining the score of logical thinking ability, this study was then persisted to dividing students into two groups namely B1 for students having high score of logical thinking ability and B2 for students having low score of logical thinking ability by using a criterion-referenced. Based on the result above, the subjects obtained for this research were named after A1B1, A2B1, A1B2, and A2B2, each consisted of 21 students. This research was categorized as quasi-experimental research using treatment by level 2 x 2 design. This was due to the presence of logical thinking ability (both high and low logical thinking ability) as a moderator variable. The independent variable was the type of assessment used in jigsaw cooperative learning method, which was divided into performance assessment and written tests. Students' Biology learning outcomes were used as dependent variable and students' prior knowledge was used as controlling variable.

Performance Assessment was measured by performance assignments; written assessment test was measured using written assignments; logical thinking ability was measured using logical thinking ability tests; learning outcomes were measured using tests of Biology learning outcomes; and prior knowledge was measured using prior knowledge tests. By using a cross-tabulation of Gregory, it was obtained the Content Validity (CV) coefficient results for performance assessment instruments was 0.93, for written test assessment was 0.93, for prior knowledge test was 0.95, logical thinking ability test was 0.98, and the test of Biology learning outcomes was 0.98. In line with the above results, by using the Hoyt formula, it was found the r_{11} coefficient for performance assessment was 0.85, for written assessment test was 0.85, for prior knowledge test was 0.77, for logical thinking ability test was 0.81, and the test of Biology learning outcomes was 0.84. The data collected for Biology learning outcomes and students' prior knowledge were then analyzed using two-way Ancova.

3. RESULT AND DISCUSSION

Result

Biology Learning Outcomes of Students Taking Performance Assessment and Written Test Assessment in Jigsaw Type Cooperative Learning Method Statistical result of F_{ratio} test = 35.725 with the value of F_{table} = 1.96. Therefore, F_{ratio} > 1.96, thus H_0 was rejected. This meant that there were differences in terms of the biology learning outcomes between students who took the performance assessment and the students who took written test assessment in Jigsaw type of Cooperative Learning method, after controlling their prior knowledge. Corrected mean score of the biology learning outcomes of students group who took performance assessment in Jigsaw type Cooperative Learning method was amounted to 6.983, while the corrected mean score of the biology learning outcomes of students group who took written test assessment in Jigsaw type of Cooperative Learning method was amounted to 6.503. Based on the corrected mean score which has been described above, it can obviously be seen that students who took performance assessment gained better results than those students who took written test assessment in Jigsaw type of Cooperative Learning method in terms of their biology learning outcomes. The Effect of Interaction between Assessment in Jigsaw type of Cooperative Learning method and Logical Thinking Ability toward Biology Learning Outcomes From the analysis, the statistical value of Test-F on line A*B obtained F_{ratio} = 164.374, and the F_{table} = 1.96. Therefore F_{ratio} > 1.96, thus H_0 was rejected. This meant that there was an influence between assessment in jigsaw type of cooperative learning method and logical thinking ability toward biology learning outcomes, after controlling the students' prior knowledge. The interaction between the assessment in jigsaw type of cooperative learning method and logical thinking ability toward biology learning outcomes can graphically be visualized as shown in Figure 1.

Biology Learning Outcomes of Students Taking Performance Assessment and Written Test Assessment in Jigsaw Type of Cooperative Learning Method for Students Having High Logical Thinking Ability

Results of testing analysis showed that the statistical value of the t-test on line [(A = 2) * (B = 1)] obtained t_{ratio} = 13.344 with the t_{table} = 1.68. Therefore t_{ratio} > 1.68, thus H_0 was rejected. This meant that in the group of students who had high logical thinking ability (B1), there were differences in terms of Biology learning outcomes between students who took performance assessment and students who took written test assessment in Jigsaw type of cooperative learning methods, after controlling students' prior knowledge. Judging from the average value between the two groups, it showed that: particularly for the group of students who have high logical thinking ability, the biology learning outcomes for those students who took the performance assessment in Jigsaw cooperative learning methods was 7.668, while for the students who took written test assessment was 6.152. From this corrected mean score, it can be inferred

that the group of students who had high logical thinking ability was more suited to take performance assessment in Jigsaw type of cooperative learning method after controlling students' prior knowledge.

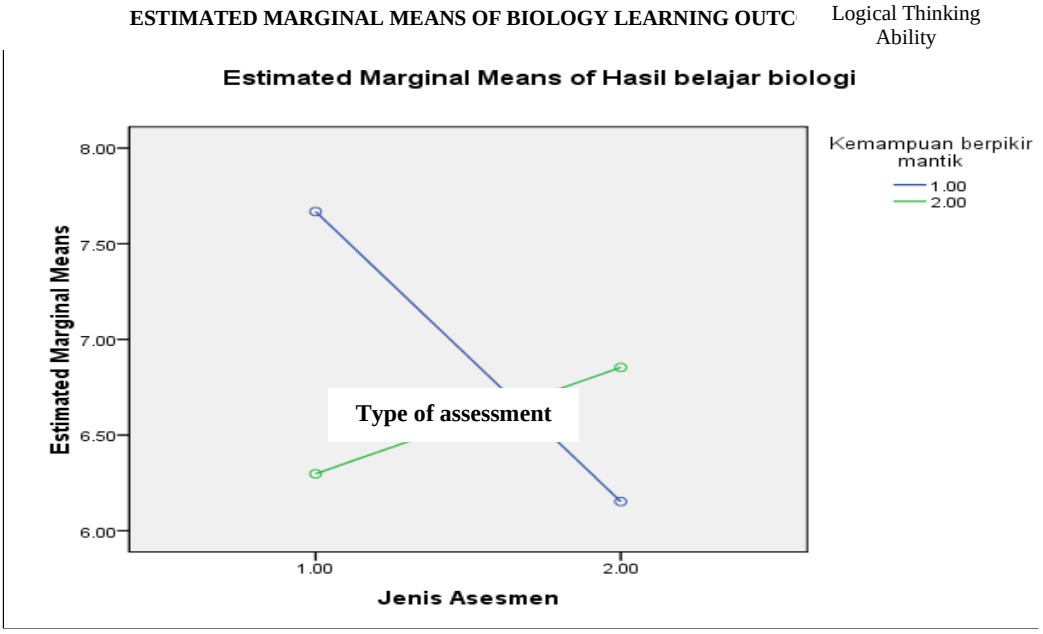

Figure 1. Visualization of the Effect of Interaction between Assessment in Jigsaw Type of Cooperative Learning Method and Logical Thinking Ability toward Biology Learning Outcomes

Biology Learning Outcomes for Students Taking Performance Assessment and Written Test Assessment in Jigsaw Type of Cooperative Learning Method for Students Having Low Logical Thinking Ability. Based on the results of the analysis, the statistical value of the t-test on line [(A = 2) * (B = 1)] obtained t_{ratio} = -4.888, while the t_{table} = -1.68. Therefore $t_{ratio} < -1.68$, thus H_0 was rejected. This meant that particularly in the group of students who had low logical thinking ability (B2), there were differences in terms of Biology learning outcomes between students who took the performance assessment and those students who took written test in Jigsaw type of cooperative learning method, after controlling their prior knowledge. Judging from the average value between the two groups, it showed that: particularly for the group of students who have low logical thinking ability, the biology learning outcomes for those students who took the performance assessment in Jigsaw cooperative learning methods was 6.297, and those students taking written test assessment in the same method of learning gained 6.853. From this corrected mean score, it can be inferred that the group of students who had low logical thinking ability was more suited to take written test assessment in Jigsaw type of cooperative learning method after controlling the students' prior knowledge.

Discussion

Biology subject is more focused on the aspects of understanding the concept as a whole, both concrete and abstract concepts. Thus, assessment is required in appropriate learning methods to deliver assignments in the classroom. Written test in jigsaw of cooperative learning methods encouraged students in the expert groups to perform tasks with the help of textbook referred by the biology teacher. This test was only able to provide an understanding of abstract concepts, so that if there was an incapability to understand the concept, the students tend to understand it by taking a backward flow according to the level of Klausmeier concept. Even when finally, the students were able to understand the concepts in the field of Biology through rote learning, it however took quite a long time. This happened because the written tests in jigsaw of cooperative learning method, it was only students who had the upper middle strata ability who are able to understand the undefined concepts, while students who had the lower middle strata ability tend to follow the opinion of the students who understand the concepts in order to seek the solution of their burden. On the other hand, the performance assessment in jigsaw of cooperative learning method could help students to understand the concrete as well as the abstract concepts. This was due to the situation in which the students in the expert groups use authentic media as a basis for understanding concepts concretely and defined concepts in the textbook as a means to understand the abstract concepts. If misconceptions occurred, a student could relate to the abstract concept or concrete

concepts, until there was a significant learning. This was in accordance with the another opinion, which in essence expressed in science learning at least occurs understanding the concept gradually on students themselves, namely from the concrete concept, the identity concept, the classification concept, and formal concepts (Ratnawati, 2016; Wahyuni & Ariyani, 2020). To be able to understand the formal (abstract) concept, it must be preceded by a concrete understanding of the concept. Likewise, with that expressed by previous research, that students who took written test in jigsaw of cooperative learning methods were forced to grasp abstract concepts through reading Biology textbooks (Karacop & Doymus, 2013; Tarhan et al., 2013). Abstract concepts were very difficult to be assimilated into the cognitive structure of students when they were not based on a concrete understanding of the concept.

In addition to the assessment in the learning method, students' prior knowledge also affected the learning outcomes. The influence of prior knowledge toward learning outcomes was in accordance with the findings of similar research, which essentially stated: (1) in the group of students who had high prior knowledge, the Biology learning outcomes of students taking the Co-Op Co-Op type of cooperative learning methods were higher than those taking conventional teaching methods; and (2) in the group of students who had low prior knowledge ability, the Biology learning outcomes of students taking the Co-Op Co-Op type of cooperative learning methods were lower than those taking conventional learning methods (Bulić et al., 2017; Sirih et al., 2020). In order to avoid the influence of prior knowledge toward the performance assessment and written test assessment in jigsaw of cooperative learning method, thus the students' prior knowledge must be controlled. Furthermore, students who took performance assessment in jigsaw of cooperative learning method could do their performance tasks in accordance with the demands of performance rubric. When the expert groups were willing to obtain maximum value according to the performance rubric attached in the performance tasks, they would use all the information obtained when observing objects, for instance flower parts using their eyes and under the microscpe and compared them with the results of reading textbooks referred by biology teachers.

Moreover, students who took performace assessment in jigsaw of cooperative learning methods could be said to have understanding of the concept as a whole (integrated). At the process of conducting the tasks, the expert groups were allowed to observe the authentic objects of generative reproduction belonged to angiosmpermae plants. When observing the authentic objects, there occurred an understanding of a concrete concept. The observation results were used as a basis to link abstract concepts found in Biology textbooks that were used as materials for accomplishing the tasks. While studying the concepts of biology, particularly regarding to the generative reproduction of angiosperms plants in Biology textbooks was considered as understanding the abstract concepts. Concrete concepts derived from direct observation of the authentic flowers and abstract concepts derived from biology books, were then subsequently assimilated into the ideas emerged in the students' mind. These phases are often known as *subsumsi* or *transcendental ego* (Ratnawati, 2016; Wahyuni & Ariyani, 2020). Assignments submitted by the expert group to the biology teacher actually are the result of understanding the concept as a whole. Hyphoteses that have been raised about the effect of the level of logic and assessment differences in cooperative learning methods used, has shown the opposite direction. Students who had high logical thinking ability were expected to have a higher Biology learning outcome when taking performance assessment in jigsaw of cooperative learning method compared to students who take written test in jigsaw of cooperative learning method.

Conversely, students who had low logical thinking ability, the biology learning outcome would be higher when taking written test in jigsaw of cooperative learning method compared to students who took performance assessment in a jigsaw of cooperative learning method. The above statement was in line with the other opinion, which principally stated that the performance assessment in jigsaw of cooperative learning method was more suitable for students who had high logical thinking ability, while written test assessment was more suitable for the students that had low logical thinking ability (Berger & Hänze, 2015; Kampourakis, 2016; Nehm, 2019). This statement was supported by empirical findings of previous research which stated that inferred significant interaction between assessment in teaching methods and learning motivation toward Biology learning outcomes (Bahri & Corebima, 2015; Husamah & Pantiwati, 2014). In other words, students who had high logical thinking ability were more suited to take performance assessment in jigsaw of cooperative learning method, while students who had low logical thinking ability were more suited to take the written test in jigsaw of cooperative learning method. The findings in this study were also supported by empirical findings of similar research, that stated there is a significant relationship between prior knowledge and Biology learning outcome of the students in class VIII SMP Negeri 1 Gerokgak (Binder et al., 2019; Sirih & Ibrahim, 2019). In order to avoid the influence of prior knowledge toward the performance assessment and written test assessment in jigsaw of cooperative learning method, thus the students' prior knowledge must be controlled. The findings in this study could also be formulated using other formulations, that the effect of the assessment in jigsaw of

cooperative learning method toward the students' Biology learning outcomes depend upon the logical thinking ability, after controlling the students' prior knowledge.Logical thinking ability is the process of thinking through combining deductive reasoning and inductive reasoning. Deductive reasoning essentially serves as a means to understand the abstract concept while inductive reasoning serves as a means to understand the concrete concept. Students who have high logical thinking ability will understand Biology concept more quickly as it is easier to associate the concept of the abstract to the concrete or vice versa from the concrete to the abstract concept. In contrast, students who have low logical thinking ability tend to find it difficult to associate the concrete concept to the abstract or vice versa. For students who have high logical thinking ability consider the process of concept assimilation and accommodation as common things to do. This statement is in accordance with previous research, that students who had high logical thinking ability were more suited to join empirical-inductive learning cycle teaching method (Atika et al., 2022; Fauzan, 2021). In this case, the learning method of empirical-inductive learning cycle was synchronized with the performance assessment used in jigsaw of cooperative learning methods, as there occurred understanding the concept as a whole (holistic) on the students. Performance assessment in jigsaw of cooperative learning method emphasizes the students' ability to exchange information, to apply social skills, to perform activity in the tasks within the group, and to understand the concept as a whole. In doing all four of these activities, is actually a high challenge and serves as direct input for students, thus the students will be more creative, critical, and have a complex thought. On the other hand, for students who are often taught using written test in jigsaw of cooperative learning method, will not be able to learn optimally, by only obtaining abstract input, and exchanging abstract information, thus no meaningful learning occurs. Hence, the students only understand abstract concepts. If there is chaos thinking, students tend to memorize (rote learning) concepts of Biology Biology Learning Outcomes of Students Taking Performance Assessment and Written Test Assessment in Jigsaw of Cooperative Learning Method for Students Having Low Logical Thinking Ability, after Controlling the Prior Knowledge

The characteristics of students who have low logical thinking ability are easily being desperate, being less active, less understand the purpose of learning, being chaotic in understanding the concept as a whole so as not to have a clear target, not being innovative in solving problems, and tend to wait interference of others in the process of learning. Students who have low logical thinking ability prefer to follow the steps of learning which are organized and clear. Performance Assessment in jigsaw of cooperative learning method is less appropriate for students who have low logical thinking ability. This is due to the students who are likely to receive information on a regular basis (sequential), be less creative, be less challenged, be slow in exchanging information, be less skillful in social interactions with classmates, and often memorize the concepts of biology. Therefore, these students will not be able to think creatively and complex when taking performance assessment. Findings of similar research showed that students having low logical thinking ability were more suited to follow conventional teaching methods (Iryance, 2014; Noer & Gunowibowo, 2018). It is due to the students who follow conventional teaching methods through the reviewing process, for instance from the formal concept to the concept of classification, continued to the concept of identity, and finally to a concrete concept. In this case, conventional teaching methods are synchronized with written test assessment in jigsaw of cooperative learning method, in which occurs the understanding of abstract concepts in students' mind. A group of students having low logical thingking ability who take performance assessment in jigsaw of cooperative learning method, often experience confusion or chaos after learning an actual concept and after learning abstract concepts. Students who belong to this group are less able to use the property to understand the concrete concept to the abstract concept, or vice versa. Biology learning outcome of the students having low logical thinking ability who were taught using methods of empirical-inductive learning cycle was lower than those students taught using a conventional method.

4. CONCLUSION

Based on the above findings and discussions, it can be concluded the following matters. Biology learning outcomes of students taking performance assessment was better than the students taking written test assessment in jigsaw of cooperative learning method, after controlling the students' prior knowledge. There was an influence of interaction between the assessment in jigsaw of cooperative learning method and logical thinking ability toward Biology learning outcomes, after controlling the students' prior knowledge. For students having high logical thinking ability were more suited to take performance assessment in jigsaw of cooperative learning method, after controlling the students' prior knowledge. For students having low logical thinking ability were more suited to take written test assessment in jigsaw of cooperative learning method, after controlling the students' prior knowledge.

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