

Encouraging students' metacognitive skills through inquiry learning

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Abstract: This study's purpose of find the inquiry-based learning effect on the metacognitive skills of high school students. This study uses a quasi-experimental method with a pre-test and post-test design. The sample size is 65 science students at a high school in Manokwari. Data analysis using the Mann Whitney test. The results showed Sig 0.00 < 0.05, which means differences in metacognitive skills in the experimental and control groups. It can be concluded that there is an effect of inquiry-based learning on students' metacognitive skills.

Keywords: Metacognitive skill, inquiry learning, high school student, biology learning

Abstrak: Tujuan penelitian ini adalah untuk menemukan efek pembelajaran berbasis inkuiri terhadap keterampilan metakognitif siswa sekolah menengah atas. Penelitian ini menggunakan penelitian kuasi eksperimen dengan desain pre-test post-test design. Jumlah sampel 65 siswa sains di sebuah sekolah menengah atas di Manokwari. Analisis data menggunakan uji mann whitney. Hasil penelitian menunjukkan sig 0,00 < 0,05 yang berarti terdapat perbedaan keterampilan metakognitif kelompok eksperimen dan kelompok kontrol. Dapat disimpulkan bahwa ada pengaruh pembelajaran berbasis inkuiri terhadap keterampilan metakognitif siswa.

Kata kunci: Keterampilan metakognitif, pembelajaran inkuiri, siswa sekolah menengah, pembelajaran biologi

INTRODUCTION

Metacognitive skills have been widely researched and constantly improved to improve students' performance in science. Iskandar (2014) states that metacognitive plays a significant part in regulating and managing an individual's cognitive processes in learning and thinking, which ultimately results in increased efficacy and efficiency in both of these activities. Hogan et al. (2015) state that the development of metacognitive skills is needed to help individuals in groups become more adaptable in social or social contexts. Metacognitive helps students to increase their level of thinking (Hamzah et al., 2022; Nunaki et al., 2019; Nusantara et al., 2021), creative thinking skills (Jia et al., 2019), and problem-solving (Hargrove & Nietfeld, 2015), Metacognitive skills can be empowered with the right implementation of learning (Amin et al., 2020). We state that metacognitive skills are important to empower students to be successful in learning.

Based on observations at a high school in Manokwari, there are several obstacles in the biology learning process; namely, the teaching used or applied by teachers is still less varied. The teacher has created a discussion group but has not yet implemented inquiry-based learning (IBL). Students are less active during the learning takes place. They quickly feel bored, do not focus on the material being taught, and students do not think critically when learning takes place. No data were found on students' metacognitive skills. This indicates that students' metacognitive skills have not been empowered in teaching. In biology learning, it is required that students be more active, not bored, and have metacognitive skills (Madang et al., 2020; Nst & Nasution, 2022; Santangelo et al., 2021).

Abstract concepts are converted into representations in IBL that enable students to gain in-depth understanding (Wang et al., 2021) and enhance thinking skills (Damopolii et al., 2021; Nasir et al., 2020) and skills (Mandasari et al., 2021; Rimalolas et al., 2021). Replacing conventional teaching with IBL does not create a loss or decrease in students' scientific performance in schools (Wen et al., 2020). However, a study by Wang et al. (2021) found that students' disinterest in IBL was because the science teacher emphasized knowledge more than inquiry. Therefore IBL must be offered for every student activity in the classroom. This allows students to increase their interest in learning science.

Several studies have shown the impact of IBL on the development of students' metacognitive skills. Andriyanto et al. (2021) used IBL on 30 students with 33 students without IBL. Their research results show that IBL effectively empowers metacognitive skills better than teaching without IBL. Another study by Lelasari et al. (2021) used IBL to improve the metacognitive skills of as many as 35 students. The results of this research show that teacher teaching problems that cause a decrease in students' metacognitive skills can be overcome with IBL. Other research also tested the effectiveness of IBL based on the student's gender Damopolii et al., (2020). Their research results show that effective metacognitive skills increase with the use of IBL. Another finding from the researcher's research is that IBL does not cause differences in students' metacognitive skills. Boys and Girls students alike can develop their metacognitive skills.

Hadizah & Muhfahroyin (2012), in their research, concluded that IBL could improve students' metacognitive abilities. In the learning process, the teacher only guides students in learning activities; the teacher is not a giver of detailed information from each learning activity, but the teacher acts as a facilitator, and students actively build their knowledge through IBL steps so that students metacognitive abilities will increase. Another study that supports the advantages of IBL on metacognitive skills is the research conducted by Hastuti et al. (2020) ; they concluded that students' metacognitive skills could be improved very well using IBL. Based on this research, it can be said that IBL can improve students' metacognitive skills. Based on several problems and solutions, This study's purpose of find the inquiry-based learning effect on the metacognitive skills of high school students.

METHOD

The research was conducted at a public high school in the Manokwari area. The population in this study was all class X science high school Manokwari. The sample is representative of the population studied. The sample used for the study was two classes, namely class X science 3 with 29 students and class X science 4 with 36 students. The research implementation tools are in the form of a lesson plan and essay questions as an instrument for measuring learning outcomes and a metacognitive skill rubric (Corebima, 2009).

The metacognitive skills test is a technique used to obtain data about students' metacognitive skills by applying an inquiry-based learning model to Ecosystem material in class X MIA SMA Negeri 2 Manokwari. The form exam used in this study consists of essay questions. Analysis of the item's content validity using the Content Validity Ratio (CVR) formula. The outcome of the evaluation is considered legitimate if the CVR ranges between 0.7 and 1. The validation results show that the CVR value is 1, indicating that the device meets the validity standard.

The calculation of metacognitive skills using the rubric is as follows (Corebima, 2009):

$$Y2 = \frac{(Y1 + 2X)}{3} \quad (1)$$

Information:

X: assessment of metacognitive skills (score rubric)

Y1: non-rubric assessment (student cognitive)

Y2: metacognitive skills

Data analysis used non-parametric analysis, namely the Mann-Whitney test. Previously, a normality test (Kolmogorov Smirnov) was carried out.

RESULTS AND DISCUSSION

This study aims to find the inquiry-based learning effect on the metacognitive skills of high school students. At the beginning of the meeting, each group was given a pre-test to determine the students' initial metacognitive skills and also as comparison data between the experimental group and the control group after being given treatment. The description of the initial metacognitive skills data is presented in Table 1.

Table 1. Description of initial metacognitive skills

Description	Experimental	Control
Maximum value	41	38
Minimum value	9.50	19
Mean	27.5	27.7
Median	30	25.8
Standard Deviation	8	5.8

The data on the achievement of metacognitive skills in Table 1 shows that the initial metacognitive skills are still low. The experimental gets a higher score than the control group, with the experimental being 41 for the highest score and the lowest score being 9.50. While the control group has the maximum metacognitive skill score of 38, the minimum score obtained is 19, with a mean of 27.7.

The Kolmogorov-Smirnov test is used to test the normality of the data. It is said to be normal if the value of Sig. > 0.05 and abnormal if the value of Sig. < 0.05. Normality testing is presented in the following Table 2.

Table 2. The normality test of the initial metacognitive skill

No	Data	Statistics	Free Degree	Sig.	Normality
1	Experimental	0.164	36	0.016	No
2	Control	0.155	29	0.092	Yes

According to the findings of the normality test in Table 2, the experimental group's value (0.016) is not normally distributed. There was a statistical significance level of 0.092 in the control group, which indicates that the data distributed is normally. The homogeneity test was not carried out because the data was not normal.

Table 3. Data on the results of the initial metacognitive skill difference test

Data	Sig.	Decision
Initial metacognitive	0.807	No difference

The data in Table 3 is a test of differences in initial metacognitive skills using the Mann-Whitney test, showing that there is no difference in scores in the two groups (Sig. = 0.807 > 0.05); it is stated that there is no difference in the metacognitive skills of the experimental group and the control group. Students were given a post-test at the end of the meeting and the completion of the treatment in the control and experimental groups. The description of the final metacognitive skills data is presented in Table 4.

Table 4. Final metacognitive skill result data

Description	Experimental	Control
Maximum value	9.70	52
Minimum value	38.40	20.90
Mean	60.8	37.3
Median	55.4	38.4
Standard Deviation	1.44	8.9

Table 4 shows the final metacognitive skill data, which shows an increase in the value of metacognitive skills than the initial value; it can be seen that the difference in the value of basic metacognitive skills in the experimental group and control group can be seen in the experimental group the scores obtained are categorized as good while the control group is still categorized as low. In the experimental group, the highest score was 95.7, and the lowest was 38.40, with a mean of 60.8. In the control group, the highest score was 52, and the lowest was 21, with a mean of 37.7.

Table 5. The final metacognitive skill normality test

No	Data	Statistics	Free Degree	Sig.	Normality
1	Experimental	0.183	36	0.004	No
2	Control	0.149	29	0.099	Yes

The normality test results in Table 5 show that the value of the experimental group is 0.004, which shows Sig. < 0.05, so the data distributed is said to be not normal—Sig. in the control group of 0.092, which shows that Sig. > 0.05, so the data is said to be normally distributed.

Table 6. The final metacognitive skill difference test result

Data	Sig.	Decision
Final metacognitive skills	0.000	There is a difference

Data Table 6 is a test employing the non-parametric (Mann-Whitney test), which shows the difference in the final value of the experimental group and the control group, so the results obtained are that there are differences that can be seen in the significance value obtained a value of 0.000. Because 0.000 < 0.05, it is stated that there is a difference in the experimental and control groups' metacognitive skills. The difference in the effect of the two lessons indicates that IBL has a stronger effect than conventional on students' metacognitive skills.

Based on the data from the initial test results presented in Table 3, the data of the pre-test in the experimental and control groups showed that the initial metacognitive skills had similar abilities. It is said that because the average value of the two classes is not much different and has been tested using a two-sided test with a significance value of 0.807 > 0.05, which means there is no difference between the control class and the experimental class in the results of the initial test. The low value of metacognitive skills on the initial test was caused because they had never studied before and answered the questions given only by their own reasoning and experience. The low value of the pre-test is because students do not have maximum preparation to work on the given pre-test. Maximum preparation is the readiness of students to understand and understand the test given.

After the initial test of metacognitive skills was carried out on students in both classes, then different treatments were given, namely, using IBL in the experimental class and conventional learning models in the control class; the learning process in the experimental class lasted for four meetings while the experimental class lasted for three meetings. After the learning process is complete, students in both classes will be given a post-test; the purpose of the post-test is given so that researchers know the effect of different treatments in each. According to Musa et al. (2021), a post-test is a test carried out to know whether all material is classified as important and can be mastered as well as possible by students. After getting the final test results and having analyzed them. It was found that the experimental class had a higher average score and could be categorized as good compared to the control class, but the control class also had an increase in the value of metacognitive skills but had not reached a good category. The experimental class obtained a mean score of 60.8 metacognitive skills from 36 students. The control class obtained a mean score of 37.3 metacognitive skills from 29 students.

After testing the hypothesis, the results obtained $0.000 < 0.05$, which shows that there is an effect of IBL on increasing students' metacognitive skills, in line with research conducted by Irawati et al. (2015), which concluded that IBL could improve students' metacognitive skills so that it can be said that IBL effects increasing students' metacognitive skills. Although this study is in line with the results of previous studies, further discussion is needed regarding metacognitive skills and why in metacognitive skills, IBL is superior to conventional learning models.

The application of the IBL in the experimental class allows students to formulate problems, make hypotheses, prove hypotheses, and conclude the material obtained. Students also make direct observations around the school so that the material obtained is more understandable because students observe directly what is in the teaching materials, from the activities carried out to find their knowledge; through observation activities, students can connect the knowledge they already have with the knowledge they do so that student's understanding of concepts is deeper, and students are also given homework assignments, namely individual assignments and assignments. So those students are able to develop their abilities in working on student worksheets; in this case, their metacognitive skills will increase. In addition, each group in the experimental class contains 4-5 people in one group, which makes students more active in the discussion.

In the control class, totaling 29 students were taught using conventional learning models in groups of 8 students, which allowed students not all to focus on the discussion because there were too many members in each group, so students played with their friends, Kusumawardani et al., (2013) also said that the negative impact of having more members in a group is longer coordination time and greater energy being contributed to the group decision-making process. In the control class, students are also given a student worksheet, but the student worksheet that is given does not contain any inquiry steps or is based on

scientific methods in the process and does not make direct observations, so students cannot connect the knowledge they already have with the knowledge they did during the observation, understanding of student's concepts will be low, this causes the students metacognitive skills in the control class not to develop because according to the results obtained that students who work on student worksheets according to the steps of inquiry, their metacognitive skills have increased.

Based on the data that has been obtained, IBL can improve students' metacognitive skills. This is in line with research by Damopolii, Keley, et al. (2020); Danila & Agustini (2021) that with the application of IBL, the metacognitive skills of students can be trained very well. The higher the metacognitive skills of students, will improve student learning outcomes. According to Ardila et al. (2013), there is a strong relationship between metacognitive skills and students' cognitive learning outcomes. The results of the research conducted by the author show that IBL affects metacognitive skills. IBL has a positive impact on students' metacognitive development.

CONCLUSION

The final test results showed that there were differences in metacognitive skills in the experimental class and control class, with a value of Sig. 0.000 0.05. There was an increase of 33.3% in the experimental (IBL group) and 9.6% in conventional (control). So it can be concluded that IBL can affect students' metacognitive skills.

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