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The Influence of Inquiry Lesson Learning on Students' Scientific Reasoning Ability in Ecosystem Material

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Abstract

Background: This study aims to determine the influence of applying the Inquiry Lesson learning model on the scientific reasoning abilities of Grade X students. **Method:** This type of research uses a quasi-experiment. The sample for this research was A total of 55 students in the science program grade 10 at one of the Madrasah Aliyah Public Schools (MAN) were involved. The instrument used is in the form of scientific reasoning ability test questions in the form of reasoned multiple-choice questions of 15 questions. The research design used is the Non-equivalent Control Group. The second instrument uses a student response questionnaire to learning using the inquiry lesson learning model, which consists of 12 questions. **Results:** The average N-Gain score was 0.48 in the moderate category, and the scientific reasoning abilities of students in the control class produced an average pretest score of 56.12 and a post-test average score of 70.13 with an average score of 70.13. N-Gain score of 0.32. The hypothesis test obtained a significance value of sig (2-tailed) 0.004, then H_0 was rejected, and H1 was accepted. The emergence of scientific reasoning abilities of experimental class students on each indicator varies but generally has an N-Gain score in the moderate category. Student response questionnaires regarding the inquiry lesson learning model showed an average score in the excellent class (61-80). **Conclusion:** There is an upsurge in inquiry lessons that teach children about ecosystems and their scientific reasoning skills.

Keywords: Ecosystem; Inquiry Lesson; Scientific Reasoning Ability

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Introduction

Scientific reasoning is one of the thinking skills that is a demand of the 21st century and is expected to be taught in science classes to prepare students to face global challenges Indah et al., (2022). Scientific reasoning is a process in which logical principles are applied to the scientific method, namely looking for problems, formulating hypotheses, making predictions, solutions, and problems, creating experiments, controlling variables, and analyzing data (Amelia, 2015). Scientific reasoning is also aligned with the 2013 curriculum in Indonesia. The 2013 curriculum states that the importance of scientific reasoning skills, as described in Permendikbud number 64 in 2013 concerning content standards regulated for students at the junior and senior high school levels, is mentioned in one of the skills that must be mastered, namely reasoning in concrete and abstract domains related to the development of learning in schools independently and using methods that are by scientific rules scientific reasoning abilities. Based on data from the PISA in 2015 shows that Indonesian students rank ninth bottom of all countries that are members of PISA with an average score of 403. This value is very far behind the PISA-rated value of 493. This shows that Indonesian students are included in categories with limited scientific knowledge, low science performance, and cannot use scientific knowledge to present data and draw valid conclusions (OECD, 2016). The results of the PISA are also to the effects of previous studies, which showed that the scientific reasoning ability of students is still low. Therefore, more efforts are needed to improve students' scientific reasoning skills (Anjani *et* al., 2020). This aligns with research (Juhanda et al., 2021); students' reasoning ability is still low. Students' low scientific reasoning ability is caused by the lack of teachers in applying reasoning skills in classroom learning.

Preliminary studies on teachers support the data; the author conducted interviews to determine whether teachers have ever achieved learning that can affect students' scientific reasoning abilities. Based on this question, the teacher's answer to guide learning using scientific reasoning skills has been applied but has not been optimal learning delivered by the teacher to students. This fact indicates that there is still a lack of learning activities that can affect the scientific reasoning ability of students. Therefore, to optimize the scientific reasoning ability of students, students must be retrained with learning models that can improve the scientific reasoning ability of students.

Purwana & Rusdiana (2021) suggest that school learning should develop scientific reasoning skills that help the younger generation face real-world problems to think and reason correctly. In addition, scientific reasoning ability is essential to know because it is a set of skills and abilities needed to solve problems in scientific investigation (Deshpande, 2013). This is shown in research conducted by (Shayer et al., 1976). One of the results concluded that the ability of scientific reasoning is related to learning outcomes in scientific content.

Scientific reasoning refers to cognitive skills in understanding and evaluating scientific information. Scientific reason is related to scientific reasoning related to skills used in scientific practice and the collection and analysis of evidence (Amelia, 2015). Based on this, a model is needed that can support student learning with students' scientific reasoning abilities (Pertiwi & Windyariani, 2022). The two are interrelated, where selecting specific models will affect the scientific reasoning ability used. In other words, the suitability between the two is to realize learning objectives (Utami & Kurniasiih, 2022).

A learning model that can increase the activeness and scientific reasoning ability of students is the inquiry lesson model, which is one of the intermediate levels of inquiry, with the characteristics of inquiry learning that can provide learning experiences for students, inviting students to conduct experiments so that they can involve students to play an active role (Nurulaini, Setiono, 2022; Setiono, 2021; Setiono et al., 2020). The selection of this inquiry lesson model is based on consideration and observation in schools. The first stage of levels of inquiry is discovery learning, based on the word that the school has applied the model and the learning is going well. The next stage of levels of investigation is an interactive demonstration (Meika et al., 2016); biology teachers have also used the model at Madrasah Aliyah. The naming itself is different, but its activities include demonstrating and enthusiastic students, especially when practicum learning is excellent. The inquiry lesson model is the subsequent and is exclusive to biology teachers. Therefore, there is a need for a new atmosphere by using the inquiry lesson model.

The material chosen is ecosystem material because the material is suitable for use in the inquiry lesson model. Ecosystem material has a relatively broad scope of material closely related to life, especially the relationship between natural phenomena and everyday life. Using ecosystem materials, we can easily relate daily problems, and the investigation process can be carried out in the school environment so that education participants can familiarize themselves with the habits of thinking about their situation (Puspita et al., 2021).

Based on the explanation above, the objectives of this study are: (1) to determine the ability of scientific reasoning of students by using inquiry lesson models on ecosystem materials; (2) to determine the differences in indicators of students' scientific reasoning ability in experimental and control classes; (3) To determine the response of students to learning by using the inquiry lesson learning model on the scientific reasoning ability of students in ecosystem materials.

Methods

The type of research used is quasi-experimental or quasi-experimental. Quasi-experimental research is a type of research that uses two groups or classes where there are experimental and control classes in testing a variable. This study aims to find the effect of specific treatments on others under controlled conditions (Sugiyono, 2017). The research design used in this study is the Non-equivalent Control Group design. In selecting the research design, there were experimental and control classes, which were not chosen randomly. This study wanted to find out whether there was an influence of using the inquiry lesson model on students' scientific reasoning abilities. To determine students' initial conditions, they are given a pretest at the beginning of learning. They are given a post-test at the end of education to determine whether students pay attention to the learning/evaluation process. For more details, the research design can be seen in Table 1.

Table 1. Research design non-equivalent control group, Sugiyono (2011)

Class	Pre-test	Treatment	Post-test
Experimental	O_1	X_1	O_2
Control	O_3	X_2	O_4

Information:
O_1: Pre-test Experimental Group
X_1: Treatment Experimental Group with an inquiry lesson
O_3: Pre-test Control Group
O_2: Post-test Experimental Group
X_2: Treatment Control Group with conventional lesson
O_4: Post-test Control Group

Participant

This research was conducted at Madrasah Aliyah Public Schools, located on Gedong Panjang, Citamiang, Sukabumi, in May 2023 for two weeks. In this study, 55 samples in Grade X were selected, which were divided into two classes, namely Science Program 1 (n=22) as the experimental group using the inquiry lesson learning model and Science Program 3 (n=23) as the control class using the conventional model (Discovery Learning) with selected by purposive sampling.

Instrument

Data analysis techniques include statistical analysis with SPSS ver. 22 and Microsoft Excel. The data obtained through the research instrument was a reasoned multiple-choice test of 15 questions to measure students' scientific reasoning abilities based on six indicators from the Lawson Classroom Test of Scientific Reasoning (LCTRS). This includes the power of conservation reasoning, proportional reasoning, probabilistic reasoning, variable control reasoning, correlational reasoning, and hypothetical-deductive reasoning in the form of student response questionnaires to the implementation of the inquiry lesson learning model, which consists of 12 questions (7 positive questions and five negative questions).

Data analysis

The data collection technique is given a pretest before the learning process, a post-test at the end of the lesson, and a learning model response questionnaire after the learning process has been completed. Then, the data were analyzed using the N-Gain test, normality test, homogeneity test, and Independent sample t-test. Questionnaire data analysis techniques for students' responses were analyzed using a Likert scale with four alternative answers: strongly agree, agree, disagree, and strongly disagree (Sugiyono, 2017).

Result

Based on the research that has been carried out, the results are obtained from the collected data. An overview of the data obtained in this study is described as follows:

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Multiple choice questions have been made to measure the extent of students' scientific reasoning abilities in ecosystem material. The results of the pretest and post-test of the experimental and control classes are presented in Table 2 below.

Table 2. Recapitulation of experimental class pre-test and post-test score data based on N-gain calculations

Class	Average Class		*N-gain*	Category
	Pre-test	*Post-test*		
Experimental	58,77	78,13	0,48	Medium
Control	56,12	70,13	0,32	Low

The N-gain results in the experimental and control classes have different criteria. The N-gain score in the experimental class was higher than in the control class. The N-gain score for the experimental class was 0.48 with moderate measures, and the N-gain score for the control class was 0.32 with low criteria. This is by Sundayana (2016), which categorizes the N-gain score into five criteria, namely high if 0.70 ≤g ≤1.00; while if 0.30 ≤g ≤0.70; low if 0.00 ≤g ≤0.30: no decrease if g=0.00 and a reduction if – 1.00 ≤g ≤0.00.

Table 3. Recapitulation of normality, homogeneity, and hypothesis tests

Testing	Class	Description	Score (sig.)	Information
Normality test (*Shapiro-Wilk*)	Experiment	*Pre-test*	0,612	Normally distributed data
		Post-test	0,222	
	Control	*Pre-test*	0,171	Homogeneously distributed data
		Post-test	0,234	
Homogeneity test	Experiment Controls	*Based on Mean*	0,839	
		Based on Median	0,840	
		Based on the median with adjusted df	0,840	
		Based on trimmed mean	0,833	
Hypothesis Test (*Independent Sample T-Test*)	Experiment	*Post-test* (sig(2-tailed))	0,004	Significantly different
	Controls	*Post-test* (sig(2-tailed))	0,004	

Furthermore, both classes' pretest and post-test scores were subjected to parametric analysis prerequisite tests, including normality and homogeneity. The normality test was carried out to determine whether the population was normally distributed. A homogeneity test is carried out to determine whether the data has a homogeneous variance. After the data is tested for normality and homogeneity and obtained with normal distribution and homogeneous variance, the analysis prerequisite test is fulfilled so that parametric tests can be carried out, namely the independent sample t-test. The data used to test the hypothesis in this study used data from the post-test results in the experimental and clear control classes. The prerequisites for parametric analysis and hypothesis testing were analyzed.

The results of the normality test using the Shapiro-Wilk test because the sample size is less than 50 shows that both classes, both the experimental class and the control class, have a significant value of more than 0.05 (sig>0.005), which means that the data in both classes are normally distributed. Once it is known that the data are normally distributed in both classes, then the homogeneity test is carried out. The results of the homogeneity test based on Table 2 above show a value of 0.840 > 0.05, which means that the data has a homogeneous distribution because the resulting significance value is greater than 0.05. After obtaining normally distributed and homogeneous data, the hypothesis is tested by an independent sample t-test. A significance value of sig (2-tailed) is 0.004, which indicates that the post-test data in the experimental class and control class differ significantly because the significance value is less than 0.05 (0.004 <0.05), so it can be seen that the hypothesis H0 is rejected and H1 is accepted. It can be concluded that the use of the inquiry lesson learning model significantly influences students' scientific reasoning abilities in ecosystem material.

Emergence of Students' Scientific Reasoning Ability in Experimental and Control Classes

We analyzed students' scientific reasoning abilities for each indicator. Post-test results in the experimental class and control class, then the N-Gain test was carried out to determine the difference between the post-test and pretest scores to determine students' scientific reasoning abilities, which showed the effect of learning in the experimental class after learning conducted by the teacher.

Table 4. Recapitulation of students' scientific reasoning ability on each indicator

No	Scientific Reasoning Ability Ability Indicator (Lawson, 2004)	Average (%)		Category	
		Experimental	Control	Experimental	Control
1	Conservation reasoning	56,82	18,84	Enough	Very Less
2	Proportional reasoning	42,72	50,45	Enough	Enough
3	Variable Control reasoning	31,06	10,85	Not Enough	Very Less
4	Probabilistic reasoning	89,51	56,52	Very Good	Enough
5	Correlational reasoning	13,64	32,60	Very Less	Not Enough
6.	Hypothetical-Deductive Reasoning	40,90	39,13	Not Enough	Not Enough
	Average	45,73	34,73	Medium	Low

It shows differences in the level of students' scientific reasoning abilities in the experimental and control classes (Table 4). At the same time, the experimental class has values ranging from significantly less, less, sufficient, and excellent categories. The category includes fine scientific reasoning abilities, namely the conservation and proportional reasoning indicators (1 and 2). Then those included in the less category are indicators (3 and 6), namely indicators of variable control reasoning and hypothetical-deductive reasoning. Then what is included in the outstanding category is indicator (4), namely probabilistic reasoning, and the last one is in the inferior category, namely the correlation reasoning indicator.

Meanwhile, the control class has starting values that fall into sufficient, less, and very less, as for those included in the sufficient category, namely indicators of proportional reasoning and probabilistic reasoning (2 and 4). Then those included in the less category are indicators of correlation reasoning and hypothetical-deductive reasoning (5 and 6). Those included in the inferior category are indicators of conservation reasoning and control variables (1 and 3).

Student Responses to the Application of the Inquiry Lesson Model to the Scientific Reasoning Ability of Students on ecosystem material

The percentage of students' responses to applying the inquiry lesson model to students' scientific reasoning abilities in ecosystem material can be seen through the graphs and tables below.

Table 5. Average percentage of student response questionnaire

No	Indicator	Average (%)	Criteria
1.	Interest in learning and motivation of students when learning using the inquiry lesson model	84,0	Very Good
2.	Motivation in following the learning process	80,3	Very Good
3.	Scientific reasoning ability on ecosystem material	50	Very Good
4.	The relationship between the inquiry lesson model and scientific reasoning abilities	82,9	Very Good
	Average	74,33	Good

The measured indicators are related to students' responses to using the inquiry lesson learning model in the learning process. Based on the data above, it can be seen in indicator one there is a response of 84.09 %. In the second indicator, which is related to the motivation of students to participate in learning, they got a very good response of 80.3 %, and then in the third indicator, related to scientific reasoning abilities regarding ecosystem material, a response of 50 % is included in the pretty good category and the fourth indicator related to the relationship between the inquiry lesson learning model with scientific reasoning abilities got a response of 82.95 %. And the average positive response of students to the inquiry lesson learning model is 93.8 %. So based on these data, it can be concluded that students responded positively to applying the inquiry lesson learning model.

Discussion

Based on the research that has been done, the results obtained in the data processing above show that learning using the inquiry lesson learning model in the experimental class influences students' scientific reasoning abilities. The scientific reasoning abilities of students in the experimental class increased compared to the control class. This is because the inquiry lesson learning model can increase the ability of students to be more active in learning activities and can emphasize activities that carry out investigations which in this study provided worksheets.

At the learning stage, students are guided by the teacher to carry out practicum properly to prove the truth of the hypothesis and find answers to problems. Students practice with friends according to the practicum steps on the student worksheet. Data from the experimental results are written in the data table on the student worksheets. This stage trains students to be able to collaborate and be responsible for tasks in their groups so that the practicum runs smoothly. The data from the experimental results that students have obtained can analyze the truth of the hypotheses that students have previously proposed. It is at this time that scientific reasoning abilities are trained. Students can draw reasonable conclusions about the problems presented at the beginning and evaluate them. After analyzing the data obtained, students present their experimental results to the class. In line with research from Anjani et al. (2020), The presentation aims to obtain agreement on what is discussed from the problem. Each stage in the inquiry lesson is designed to train students' scientific reasoning abilities.

Thus, as one of the inquiry-based learning models, the inquiry lesson learning model can help learner-centered learning. Because students can be actively involved and can solve problems in the investigation process carried out by students, this is what makes the scientific reasoning abilities of students in the experimental class superior to the control class.

In addition to seeing the emergence of students' scientific reasoning abilities for each indicator in the experimental and control classes, it can be seen from the difference in the percentage of N-Gain values for each indicator for the two classes. Meanwhile, based on the research results obtained from the scientific reasoning ability test shows that generally, the scientific reasoning abilities in the experimental class are in the category of "less" "sufficient," and "very good" improvement, while those in the control class are in the "very poor" category. "less" and "enough" The results of data acquisition from the test are given directly to the class in the form of a test sheet.

The category of scientific reasoning ability for each student in the experimental class and the control class as a whole can be seen in Table 4. The table shows that students in the experimental class have better scientific reasoning abilities than students in the control class. This is because the experimental class uses a learning model that can train students' scientific reasoning abilities. Differences in students' scientific reasoning abilities seen from each overall indicator can be seen in Table 4.

The emergence of students' scientific reasoning abilities per indicator between the two classes shows that there is a difference in the increase in students' scientific reasoning abilities in ecosystem material. Based on the percentage category, the average value of increasing scientific reasoning ability in the experimental class per indicator is included in the sufficient category with an average 45.73 %. In the control class, it is included in the low category with an average percentage value of N-Gain (34,73 %). This is because the two classes use different learning models. The experimental class uses the inquiry lesson learning model. The role of the teacher in learning that is applied to the inquiry lesson learning model is to provide more guidance to students directly. Therefore, learning the inquiry lesson in the experimental class can have a positively impact.

Based on the research data in Table 4, the percentage increase in scientific reasoning ability based on the overall N-Gain for each indicator of scientific reasoning from the experimental class and control classes has a different value. In the experimental class, the first indicator, namely conservation reasoning, obtained a percentage of values included in the sufficient category (56.82 %). In the control class, 18.84 % was included in the low category. This shows that the experimental class is superior to the control class and that the experimental class is quite capable of understanding that certain properties of objects cannot change even though other objects influence them (Handayani et al., 2020).

The second indicator, the proportional reasoning indicator in the experimental class (42.72 %), which was included in the sufficient category. In the control class, it obtained a value of 50.45 %, which was included in the sufficient category. The results in the experimental class show that students are sufficiently capable of reasoning abilities with two variables, both of which have a linear functional relationship which will lead to conclusions about simulations or phenomena that have constant ratios or comparisons (Shofiyah et al., 2013). The results of this study align with research conducted by Anjani et al. (2020). This indicator has a sufficient increase, namely proportional reasoning because most of the students' answers are in the Tr (Transitional) category.

In the third indicator, controlling variables in the experimental class (31.06 %) was included in the less category, and the control class was included in the very lacking category (10.85 %). The variable control pattern is one of the most difficult types because students have to choose one variable with the most distracting variables. Based on the research results, many of the students were fooled by the variables presented, so few of the students still answered questions about the pattern of controlling variables with inaccurate answers. In addition, some students answered the questions correctly but could not explain why they chose that answer. As a result, the scores obtained were less than perfect, which states that students have low scores on variable control patterns. This has similarities with research conducted by (Sopian, 2019) because students still have difficulty determining and distinguishing existing variables.

In the experimental class, the indicator that obtained the highest score was the fourth indicator, namely probabilistic reasoning. Probabilistic reasoning was an indicator that received the highest percentage (89.51 %), which was included in the very good category. Then the control class is included in the sufficient category with a percentage value of 56.52 %, meaning that experimental class students are better at using the information to conclude. In line with research conducted by Jariah (2022), probabilistic reasoning is one of the reasoning patterns that get results that fall into the very good category because it is good enough to determine and predict the opportunities that will occur in an object or event. This study is inversely proportional to the results of research conducted by Handayani et al. (2020), that probabilistic reasoning has a percentage that falls into the category of very less.

The fifth indicator, correlation reasoning in the experimental class, obtained a score including the very least category of 13.64 %. On the other hand, correlation reasoning in the category control class was very lacking in obtaining a percentage value of 32.60 %. This is because when learning is carried out, lesson investigators do it by doing practicum activities that allow students to spend a longer time. In addition, student learning activities are not always conducive to learning, which can interfere with student concentration during learning. Supported by students' responses to the reasoning ability activities that have been carried out in class with an average score of 50 with fairly good criteria, it means that students have not fully mastered the scientific reasoning skills that have been taught. This research is inversely proportional to the results of research conducted by Nabillah et al. (2022), where correlation reasoning gets the highest value of 83.33 which falls into the very good category.

In the hypothetical-deductive indicator, the sixth indicator has less percentage value in both experimental and control classes. According to Jariah (2022), hypothetical-deductive reasoning is reasoning where a child can develop hypotheses about how to solve problems and lead to a conclusion. Other than this, the reasoning pattern is considered the most difficult. Based on research conducted in the experimental class, the value obtained by 40.90% was included in the low category, and the control class, the value obtained by 39.13% was included in the lower category (Purnama et al., 2022). This is because many students still have difficulty when determining reasons in formulating hypotheses and making conclusions based on the information obtained. This is almost high school, with research conducted by Sari & Zulhelmi (2019) showing that most students cannot so correctly ve problems that refer to hypothetical-deductive reasoning patterns co. This research is also in line with research conducted by Jariah (2022), that many students have difficulty formulating hypotheses and making conclusions from some of the information provided, and some students do not answer. This is because some students are less able to make hypothetical decisions, resulting in students being unable to do deductive reasoning or draw conclusions. There are several possibilities for obtaining sufficient n-gain scores in experimental classes, including students who are not used to using the inquiry lesson learning model, where students must investigate a phenomenon, determine work steps and determine hypotheses to answer what is not yet known.

The increase in grades and the acquisition of increased degrees are supported by the student's response to the learning model that has been carried out. After the learning process was completed, the response questionnaire was given to students in the experimental class. The questionnaire consists of 12 questions, seven positive and five negative questions. This response questionnaire provided four alternative answers: Strongly Agree, Agree, Disagree, and Strongly Disagree (Sugiyono, 2017). Questionnaire data analysis was processed using the Likert scale category using the Microsoft Excel application. The interpretation of the Likert scale category adopts from (Arikunto, 2010), that is, the category is very good if the score range is 81-100; good if the score range is 61-80; enough if the score range is 441-60; less if the score range is 21-40 and very less if the score range is 0-20.

A recapitulation of the results of student responses is shown in Table 5 above. Students respond positively to applying the inquiry lesson model, especially ecosystem materials. The data analysis results show the percentage of student responses to learning with the inquiry lesson model applied during learning activities on ecosystem material in experimental classes. From the response questionnaire, it is known that the first indicator is 84.09 % of interest and motivation of students when learning using the inquiry lesson model increases, the second indicator is 80.3 % motivation in following the learning process increases, the third indicator is 50 % scientific reasoning ability on ecosystem material is sufficient, and the fourth indicator is 82.95 % of the relationship between the inquiry lesson model, and the ability to reason is improved. The average of student response questionnaires was 74.33% with good categories.

According to Wenning (2011), the Learning Model with inquiry lessons can make students more active and get used to good thoughts. This aligns with the learning experimented practicum. A unique thing is done by students, namely by identifying a practicum experiment where students can explore knowledge that has not been done before. Students continue asking questions actively when they find a phenomenon in practicum activities. In line with the research of Pertiwi & Windyariani (2022), the inquiry lesson model is expected to provide direct experience and can train students' thinking habits because thinking habits also come from the background.

Conclusions

Based on the results of the research that has been carried out, it is concluded that learning using the inquiry lesson model significantly affects students' scientific reasoning abilities. The response questionnaire related to inquiry lesson learning shows that the inquiry lesson learning model shows that students give a positive response with a percentage of 74.33 %. This figure is in the 'good' category, meaning that students realize that inquiry lesson learning gives a new impression on learning and makes it easy for them to understand learning material.

Declaration statement

The authors reported no potential conflict of interest.

References

Amelia, L. (2015). Stimulasi Kecerdasan Visual Spasial Dan Kecerdasan Kinestetik Anak Usia Dini Melalui Metode Kindergarten Watching Siaga Bencana Gempa Bumi Di Paud Terpadu Permata Hati Banda Aceh. *Stimulasi Kecerdasan Visual*, *6*(2), 26–39. https://doi.org/10.46244/visipena.v6i2.363

Anjani, F., Supeno, S., & Subiki, S. (2020). Kemampuan Penalaran Ilmiah Siswa Sma Dalam Pembelajaran Fisika Menggunakan Model Inkuiri Terbimbing Disertai Diagram Berpikir Multidimensi. *Lantanida Journal*, *8*(1), 13. https://doi.org/10.22373/lj.v8i1.6306

Arikunto. (2010). Psychol 3. *Prosedur Penelitian Suatu Pendekatan Praktik.*, *34*(2010), 92–96.

Deshpande, S. (2013). o the Main Reason Is That the Central Heart and the Person Who is in the Middle of the Day Will Be Able to Open and Close the Room. *Journal of the American Chemical Society*, *123*(10), 2176–2181.

Handayani, G. A., Windyariani, S., & Yanuar Pauzi, R. (2020). Profil Tingkat Penalaran Ilmiah Siswa Sekolah Menengah Atas Pada Materi Ekosistem. *Biodik*, *6*(2), 176–186. https://doi.org/10.22437/bio.v6i2.9411

Indah, I. A. A., Supeno, & Wahyuni, D. (2022). Pengaruh Model Problem-Based Learning Disertai Lkpd Berbasis Multirepresentasi Pada Pembelajaran Ipa Terhadap Scientific Reasoning Skills Siswa Smp. *LENSA (Lentera Sains): Jurnal Pendidikan IPA*, *12*(2), 97–104. https://doi.org/10.24929/lensa.v12i2.226

Jariah, Y. A. (2022). Analisis Kemampuan Penalaran Ilmiah (Scientific Reasoning Ability) Siswa Sekolah Adiwiyata (Tiap Tingkatan Kelas) Dalam Pemecahan Kasus Isu-Isu Ekologi. *Skripsi Pendidikan Biologi UIN Syarif Hidayatullah Jakarta*.

Juhanda, A., Rustaman, N. Y., Hidayat, T., & Wulan, A. R. (2021). Identification of Formal-Post Formal Reasoning Prospective Biology Teachers on Three Aspects of Courses. *Jurnal IPA & Pembelajaran IPA*, *5*(1), 68–76. https://doi.org/10.24815/jipi.v5i1.19708

Lawson, A. E. (2004). The Nature and Development of Scientific Reasoning: A Synthetic View. *International Journal of Science and Mathematics Education*, *2*(3), 307–338. https://doi.org/10.1007/s10763-004-3224-2

Meika, Suciati, & Karyanto, P. (2016). Pengembangan Modul Berbasis Inquiry Lesson Untuk. *Jurnal Inkuiri*, *5*(3), 90–103. https://doi.org/10.20961/inkuiri.v5i3.9450

Nabillah, Suhendar, S. (2022). *Analisis Profil Kemampuan Penalaran Ilmiah Siswa SMA kelas XI melalui Model Pembelajaran Creative Problem Solving*. *08*, 125–132.

Pertiwi, K., & Windyariani, S. (2022). *BIODIK: Jurnal Ilmiah Pendidikan Biologi Penerapan Model Inquiry Lesson Terhadap Habits Of Mind Peserta Didik Kelas X MIPA Pada Materi Ekosistem (Application of the Inquiry Lesson Model to the Habits of Mind of Grade X Mathematics and Natural Sciences Stu*. *08*, 153–160. https://doi.org/10.22437/bio.v8i4.19118

Purnama, M.E., Hidayat, S., Siroj, R.A. (2022). Guided Inquiry-Based Electronic Module Development on Circulation System Ma-Terial to Improve Student Learning Outcomes. *BIOEDUSCIENCE*, 6(1), 20-30. https://doi.org/10.22236/j.bes/617089

Purwana, U., & Rusdiana, D. (2021). Kemampuan awal penalaran ilmiah konsep fluida statis mahasiswa calon guru fisika: analisis model rasch. *WaPFi (Wahana Pendidikan Fisika)*, *6*(1), 118–124. https://doi.org/10.17509/wapfi.v6i1.32461

Puspita, Z., Juhanda, A., & Windyariani, S. (2021). Pengaruh Pendekatan Inkuiri-Kontekstual Berbasis Teknologi Informasi Terhadap Keterampilan Proses Sains Peserta Didik SMA Pada Konsep Ekosistem. *Biodik*, *7*(3), 176–184. https://doi.org/10.22437/bio.v7i3.13430

Putri Nida Nurulaini, Setiono, dan G. N. (2022). PENGEMBANGAN MODUL ONLINE BERBASIS INQUIRY DENGAN LINGKUNGAN HIDUP. *Bioscientist : Jurnal Ilmiah Biologi*, *10*(1), 490–503. https://doi.org/10.33394/bioscientist.v10i1.5351

Sari, L. I., & Zulhelmi, A. (2019). An Analysis Scientific Reasoning Ability of Grade X Student SMAN at Tampan District Pekanbaru in Subject Work and Energy. *Jom Fkip*, *6*(2), 1–14.

Setiono. (2021). *Jurnal Ilmiah Edukasia (JIE) Conceptual Framework Of Inquiry-Based Practical Work Through Online*. *1*(1).

Setiono, S., Nuranti, G., & Agustini, M. M. (2020). Meningkatkan Hasil Belajar Peserta Didik Melalui Aktivitas Saintifik Dan Visualisasi. *Jurnal Pendidikan Sains (Jps)*, *8*(1), 27. https://doi.org/10.26714/jps.8.1.2020.27-31

Shayer, M., Küchemann, D. E., & Wylam, H. (1976). the Distribution of Piagetian Stages of Thinking in British Middle and Secondary School Children. *British Journal of Educational Psychology*, *46*(2), 164–173. https://doi.org/10.1111/j.2044-8279.1976.tb02308.x

Shofiyah, N., Supardi, Z. A. I., & Jatmiko, B. (2013). Mengembangkan penalaran ilmiah (Scientific reasoning) siswa melalui model pembelajran 5E pada siswa kelas X sman 15 surabaya. *Jurnal Pendidikan IPA Indonesia*, *2*(1), 83–87. https://doi.org/10.15294/jpii.v2i1.2514

Sopian, H. (2019). Deskripsi Kemampuan Berpikir Logis dan Pemahaman Konsep Sistem Hormon pada Siswa Kelas XI SMA. *Edubiologica Jurnal Penelitian Ilmu Dan Pendidikan Biologi*, *7*(2), 85. https://doi.org/10.25134/edubiologica.v7i2.3023

Sugiyono. (2017). *Download metode penelitian kuantitatif kualitatif dan r & d sugiyono pdf Click here to get file*. 380.

Sugiyono. (2011). Metode Penelitian Kuantitatif Kualitatif dan R&D. intro (PDFDrive).pdf. In *Bandung Alf* (p. 143).

Sundayana, R. (2016). *Statistika Penelitian Pendidikan*. Alfabeta.

Utami, A. D., & Kurniasiih, M. D. (2022). Persepsi dan Sikap Calon Guru Biologi Terhadap Potensi Instagram Sebagai Sarana Edutainment dalam Pembelajaran Biologi. *Biodik*, *8*(1), 120–129. https://doi.org/10.22437/bio.v8i1.15854

Wenning, C. J. (2011). Level of Inquiry: Using Inquiry Spectrum Learning Sequences on Teach Science. *Journal of Physics Teacher Eucation Online*, *6*(2), 11–20.