Utilizing standardized test and certainty of response index (CRI): science olympiad preparation cases

Ogi Danika Pranata[1]*, Nobel Marshal[2]

[1,2]*Physics Education, State Islamic Institue of Kerinci, Sungai Penuh, Jambi, Indonesia*
*Correspondence: ogidanika@gmail.com

	Abstract
Keywords: Certainty of Response index (CRI); Earth Science; Olympiad; Science; Test;	This study focuses on Earth Science Olympiad prepation through assistance activities and utilizing a standardized test known as The Earth Science Standards Test. The assistance activities consisted of ten sessions, including pre-test, face-to-face learning, and post-test. Quantitative methods with a pre-test and post-test design were applied. The study evaluated the increase in students' scores using the N-Gain. Additionally, students were asked to indicate their level of confidence or Certainty of Response Index (CRI). Results revealed that the average pre-test score was low (46.03), suggesting that students' prior knowledge of Earth science was limited. However, after participating in the assistance activities, students demonstrated improvement, as evidenced by the average post-test score (69.29) and a moderate N-Gain score (0.41). Individual student improvements were also classified as moderate, except for one student (E). The study further analyzed the correlation between students' answers and their levels of confidence using either the Pearson test or Spearman's rho. Overall, a significant and strong correlation was observed ($r = 0.628$, $\rho = 0.000$). However, only students B, D, and F showed a significant relationship between their post-test scores and CRI. This indicates that the level of student confidence does not guarantee high scores on the test, although this pattern holds true for several students. In conclusion, format of the test used in Olympiad preparation plays a crucial role in students' performance. Further research are recommended to extend the use of standardized tests to assess students' understanding in various science learning and better understand and address factors impacting students' performance and confidence in science learning and olympiad.

Introduction

Science and technology have become essential parts of life in the present and future eras. Therefore, the understanding of science and technology needs to be emphasized and improved from an early stage. Efforts to enhance the understanding of science and technology are not only carried out within formal science learning environments but are also encouraged through science competitions. The competitive learning environment is required to accelerate the growth of scientific and technological knowledge. The best and most popular competition globally is the Science Olympiad, which aims to provide students with opportunities to explore their abilities in science and technology, enabling them to reach their full potential (Puspresnas, 2023).

The Science Olympiad has become an annual event in various countries, including Indonesia. Nationally, the Olympiad in Indonesia are held annually and gradually, starting

from the School Level (Olimpiade Sains Nasional Tingkat Sekolah or OSN-S), followed by the Regency/City level (Olimpiade Sains Nasional Tingkat Kabupaten/Kota or OSN-K), Provincial level (Olimpiade Sains Nasional Tingkat Provinsi or OSN-P), and finally, the National level (Olimpiade Sains Nasional or OSN) (Puspresnas, 2022, 2023). There are nine disciplines or fileds of science included in the Science Olympiad at the senior high school: Physics, Chemistry, Biology, Mathematics, Computer, Economics, Geography, Earth Science, and Astronomy. Through the progressive stages of the Olympiads, best students at each level and in each discipline advance and participate in the next-level competitions, culminating in International Science Olympiads.

Internationally, science olympiads are also held annually, where each country sends their best delegation to compete in various scientific disciplines (Puspresnas, 2022, 2023). The best delegates are selected from the champions of the Olympiads held in each country. The Science Olympiads have grown and developed into prestigious events for students around the world. Therefore, it is crucial for various stakeholders, such as schools, District/City Education Offices, Provincial Education Offices, and the Ministry of Education to provide special attention and support for science olympiad activities and their preparation at each level (Pranata et al., 2023). Support and attention from the beginning are necessary to facilitate students' participation in the Olympiads.

Schools can implement various plans and strategies to support students' involvement in the science olympiads, such as providing assistance and preparations for the Olympiad, planning strategic learning aligned with Olympiad activities (Pranata, 2023b), implementing problem-based or puzzle-based learning approaches (Pranata, 2021b), establishing partnerships with universities and colleges (Pranata, 2021a), organizing science olympiad summer camps (M. C. Oliver, 2017; M. Oliver & Venville, 2011), and more. However, it is essential that every plan and strategy implemented includes a final step in the form of an evaluation for prospective school-level Olympiad participants. Test assessments are commonly used for this purpose

The Olympiads particularly was test application, reasoning, and understanding of the body of knowledge (M. C. Oliver, 2017). The format of the test or assessment plays a significant role in determining students' success in participating in the science olympiads (Özlen & Özgün, 2013). A good and appropriate test should be able to measure and evaluate students' knowledge and abilities in the respective subjects. The test must has four characteristics, namely being valid, reliable, objective, and referenced (Mayer, 2011). Consequently, the development of test instruments for various disciplines of science is ongoing, not only for the science olympiads but also for science learning in school setting. In the Earth Sciences, for instance, there is the Earth Science Standards Test. This test is administered as part of the Standards Testing and Reporting Program (STAR) under the policies established by the State Board of Education in California.
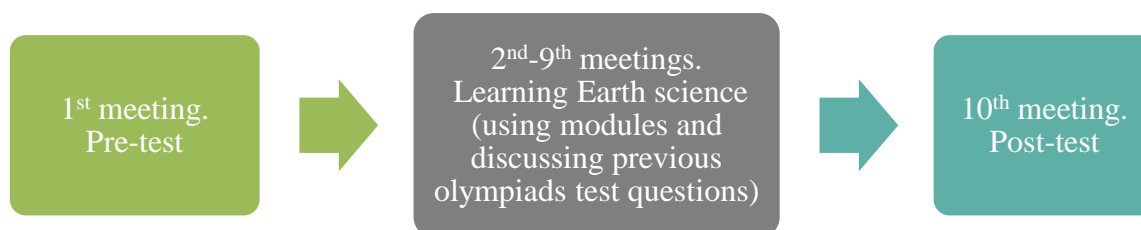
The Earth Science Standards Test can be use to help teacher assess and evaluate students' conceptual understanding in Earth Science Olympiad preparation. Earth science receives limited attention and is not yet considered as main subject in Indonesia, making the Earth Sciences field one of the most challenging in the science olympiads (Pranata, 2021a). Efforts to increase student competency in Earth sciences are needed (Amijaya, 2016). The concept test in the earth science can serve as an evaluation instrument for prospective science

olympiads participants. This test helps to assess students' initial knowledge before mentoring activities and also tracks their knowledge growth by administering identical tests at the end of mentoring sessions. Consequently, teachers can identify areas that need improvement and better prepare students for the science olympiads.

Therefore, the application of test standards is considered an important and useful effort to enhance students' readiness to participate in the science olympiads, requiring further research. Additionally, student self-confidence is also important factor to succes in science olympiads (Özlen & Özgün, 2013). So teachers not only have to focus on earth science content but also student self-confidence in mentoring activity (Greco & Almberg, 2016). Then examining the relationship between students' answers and their confidence levels when responding to questions is also essential.

Method

The study aimed to assist students in preparing for participation in the science olympiads, specifically in the field of Earth Sciences. Quantitative methods with a pre-test and post-test design were applied. The activity was conducted by Senior High School 2 Sungai Penuh in collaboration with State Islamic Institue of Kerinci. The school prepared students for mentoring in each science olympiads field, with 7 students participating in the Earth Science. Collaborative assistance activities have been proven effective in supporting science olympiads preparation (Pranata, 2021a). Mentoring sessions consisted of 10 meetings, including a pre-test, face-to-face learning, and a post-test as show in Figure 1.

Figure 1. Mentoring Sessions

The test instrument was used to measure students' knowledge before and after participating in the mentoring sessions. The pre-test utilized The Earth Science Standards Test (http://earthguide.ucsd.edu/eoc/eoc_teachers_hs_earth/pdf/rtqearthscience.pdf). which consisted of 60 multiple-choice questions. The post-test items were prepared by combining items from The Earth Science Standards Test with questions from previous Earth Science Olympiads, resulting in a post-test comprising 40 multiple-choice questions. The Questions were aligned by matching the item indicators in The Earth Science Standards Test (17 questions) with questions from previous Earth Science Olympiads (23 questions). The purpose of the combination is to better prepare students for the science olympiads, especially earth science field. The questions were categorized into several sub-topics, including earth, fire, water, air, and ether. The Earth Science Standards Test questions used were divided into 5 questions for the topic of earth and fire, 2 questions for water, 5 questions for air, and 5 questions for ether, as shown in Table 1.

Table 1. The Earth Science Standards Test questions on the pre- and post-test.

Questions Number		Topics in Earth Science Olympiad	Indicator
Pre-test	Post-test		
22	1	Earth & Fire	Students know the principal structures that form at the three different kinds of plate boundaries.
31	5	Earth & Fire	Students know the geology for the resources of major economic importance.
23	6	Earth & Fire	Students know how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.
26	9	Earth & Fire	Students know why and how earthquakes occur and the scales used to measure their intensity and magnitude.
3	10	Earth & Fire	Read and interpret topographic and geologic maps.
46	11	Water	Students know rain forests and deserts on Earth are distributed in bands at specific latitudes.
52	15	Water	Students know the carbon cycle of photosynthesis and respiration and the nitrogen cycle.
42	21	Air	Students know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.
44	22	Air	Students know the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers.
47	23	Air	Students know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.
56	24	Air	Students know the thermal structure and chemical composition of the atmosphere.
39	25	Air	Students know the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect.
2	31	Ether	Formulation explanation using logic and evidence.
11	32	Ether	Students know the evidence indicating that the planets are much closer to Earth than the stars.
15	33	Ether	Students know the evidence for the dramatic effects that asteroid impacts have had in shaping the surface of planets and their moons and in mass extinctions of life on Earth.
14	35	Ether	Students know the Sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.
5	40	Ether	Recognize the issue of statistical variability and the need for controlled tests.

In addition to answering the post-test questions, students are also asked to provide a level of confidence or Certainty of Response Index (CRI) when answering those questions. The confidence level is measured on a five-point scale (1-5), ranging from a total guess to very sure. The data on students' confidence levels when answering the post-test questions can be used to analyze their understanding in more depth (Hasan et al., 1999). One possible analysis is to examine the correlation between students' answers on the post-test and their level of confidence. This correlation analysis can be performed using either Pearson or Spearman's rho test, depending on whether the data is parametric or not. Both tests can be conducted using the SPSS application.

Pearson correlation is suitable for assessing the strength and direction of a linear relationship between two continuous variables, assuming the data is normally distributed and meets parametric assumptions. On the other hand, if the data does not meet parametric assumptions, Spearman's rho test can be used as a non-parametric alternative. Conducting this correlation analysis can provide valuable insights into the relationship between students' confidence levels and their performance on the post-test questions, helping to assess the depth of their understanding in the Earth Sciences field.

Based on the data of pre-test and post-test scores, the increase in student scores can be measured using the N-Gain score (Hake, 1998). The pre-test and post-test values are converted to a scale of 100, and the following formula is used:
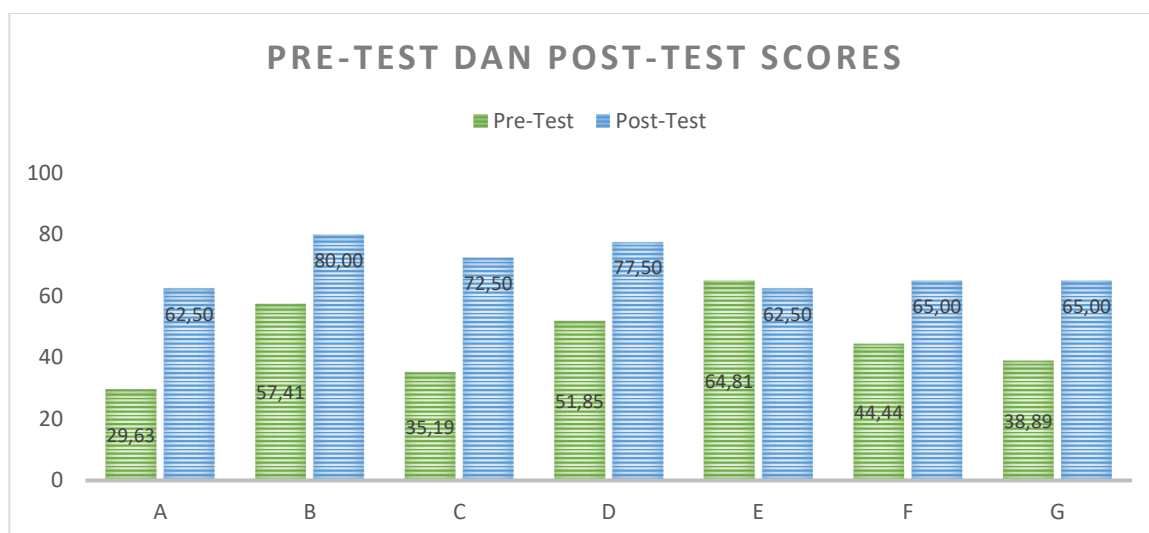
$$N - Gain\ Score = \frac{Post\ Test\ Score - Pre\ Test\ Score}{Maximum\ Score - Pre\ Test\ Score}$$

The maximum score is equal to 100. Based on the calculation using the above equation, the increase in each student's score can be categorized based on the N-Gain score obtained (Hake, 1998). The increase is considered low when the N-Gain score is less than 0.3. It is classified as moderate when the N-Gain score is greater than 0.3 and less than 0.7. Finally, the increase is considered high when the N-Gain score is greater than 0.7. Using the N-Gain score allows teachers to understand the extent of improvement in students' performance after participating in the mentoring sessions. It provides a quantifiable measure to assess the effectiveness of the intervention and can help identify students who have shown significant progress in their understanding of Earth Sciences.

Results and Discussion

Pre-test and Post-test Scores

The results and discussion are based on the data collected from the pre-test and post-test conducted before and after the mentoring sessions. Both sets of data were analyzed using descriptive statistics to provide an overview of students' overall knowledge in the field of Earth Science. The results of the overall data analysis are presented in Figure 2. Additionally, the N-Gain scores, calculated based on the pre-test and post-test scores of each student, are displayed in Figure 3.

Figure 2. Pre-test and Post-test Score for Each Student
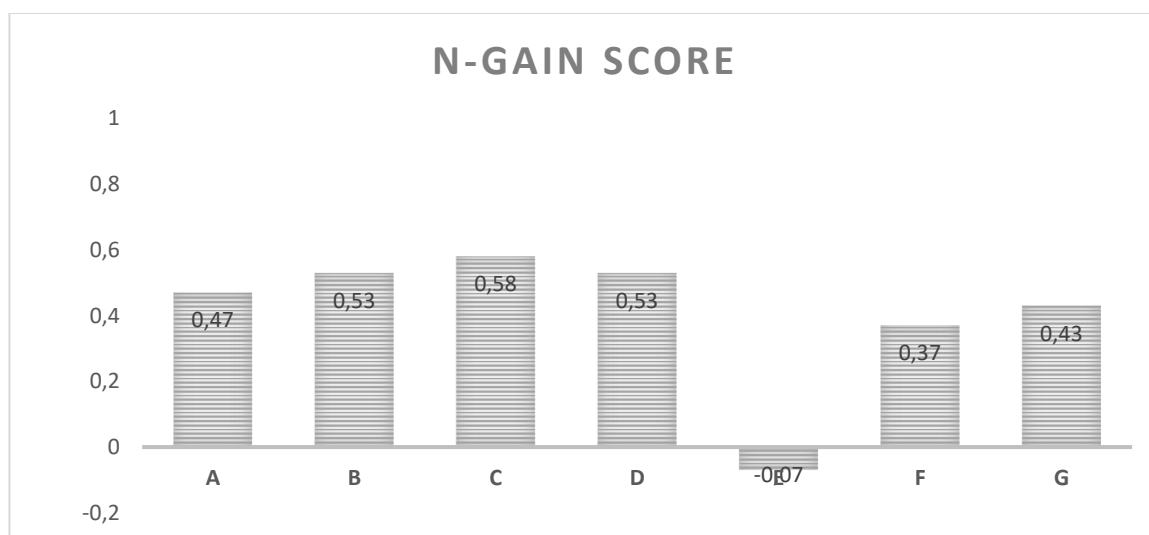
Figure 3. N-Gain Score for Each Student

The combination of Figures 2 and 3 allows for a comprehensive understanding of students' initial knowledge levels, the overall impact of the mentoring sessions on their performance, and the distribution of N-Gain scores across the group. This information can be used to evaluate the success of the mentoring program and to identify areas that may require further improvement. The discussion section can delve into the implications of the findings and provide suggestions for future interventions or modifications to enhance students' preparedness for science olympiads in the field of Earth Sciences.

Based on the pre-test data, the average score was 46.03, ranging from 29.63 to 64.81. These results indicate that students' initial knowledge of the Earth is relatively low. This finding can be attributed to the fact that students do not study Earth as a separate and main subject at school (Pranata, 2021a, 2023b), resulting in limited familiarity with Earth-related concepts. Instead, their understanding is mainly derived from cross-curricular concepts taught in subjects such as physics, chemistry, biology, and geography. Therefore, it is necessary to provide assistance through learning and mentoring to prepare them to participate in the science olympiad, especially in Earth Sciences. The mentoring sessions can help bridge the

knowledge gap and enhance students' understanding of Earth Sciences concepts. By doing so, students can increase their N-Gain scores (as shown in Figure 3) and significantly improve their performance in the post-test, which is essential for their successful participation in the science olympiad. Moreover, addressing the limited attention given to Earth Sciences in the education system can lead to better-prepared students and foster a stronger interest in the subject, benefiting them in the long run.

After participating in the mentoring sessions, students' knowledge was reassessed through the post-test, and the results showed an improvement, with an average score of 69.29, ranging from 62.50 to 80.00. This indicates an increase in students' knowledge. The degree of improvement can be determined by the N-Gain scores. Overall, the N-Gain value was found to be 0.41, which falls within the moderate category. The increase for each student was also classified as moderate, except for student E, who had a negative N-Gain score. Negative N-Gain score implies that the post-test score is lower than the pre-test score. In other words, there was a decline in knowledge. It is important to further explore the condition of student E using other approaches, such as mixed methods, to understand the reasons behind the decline in knowledge despite having the highest pre-test score. By using mixed methods, researchers can gain more comprehensive insights into the factors that might have influenced the negative N-Gain score.

The variation in student N-Gain scores can be influenced by various factors, mainly related to concept acquisition and students' self efficacy. Concept acquisition is particularly crucial when students' initial knowledge is low. Understanding whether students' concept acquisition was lost, held, or increased during the mentoring sessions can provide valuable information about their conceptual understanding (Pranata, 2023a). Students' self efficacy also plays an important role, especially when their initial knowledge is low. High self-efficacy can increase a student's belief in their ability to tackle challenging tasks and maintain intrinsic motivation (Özlen & Özgün, 2013). This condition is particularly relevant in the competitive environment, where students need confidence and motivation to perform at their best.

By considering these factors, educators and researchers can better understand the impact of mentoring sessions on students' knowledge and identify areas for improvement in future interventions. Additionally, addressing the influence of self-efficacy and concept acquisition can help create more effective learning strategies to support students' participation in science olympiads and overall academic achievement in the field of Earth Sciences.

Certainty of Response Index (CRI)

The researcher conducted an analysis of the students' post-test scores using the Certainty of Response Index (CRI), which involves considering the students' level of confidence when answering the questions. The CRI approach can help teacher identify any misconceptions that may arise when using multiple-choice questions (Hasan et al., 1999). Figure 4 presents the data depicting the students' answers to each question and their corresponding confidence levels, which are rated on a scale of 1-5. The scale was converted to 100 scale. The relationship between students' confidence levels (CRI scores) and their performance (post-test scores) was provided by scatterplot in Figure 5.
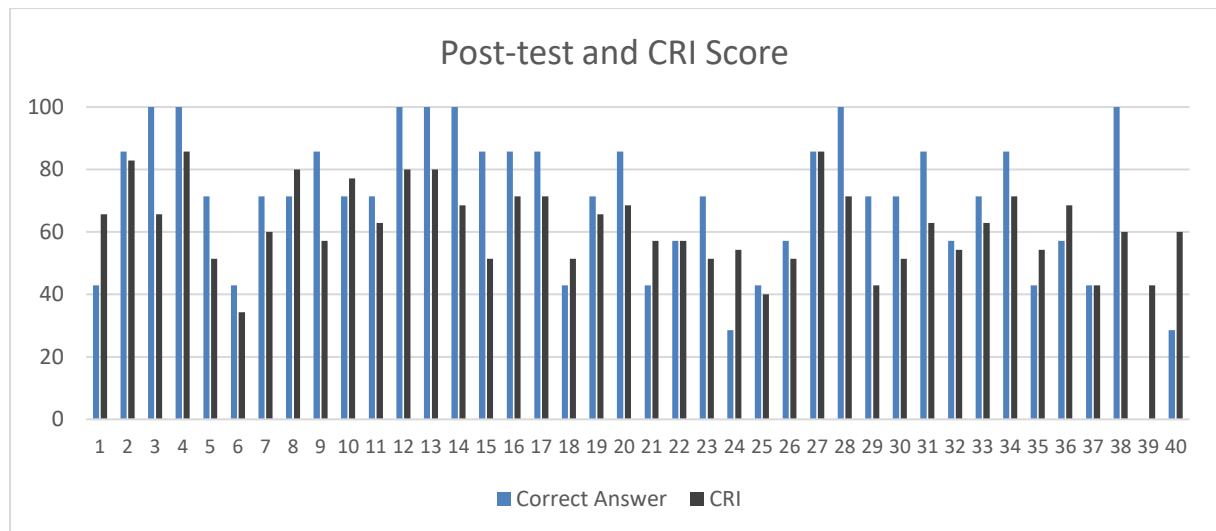
Figure 4. Post-test and CRI Score for Each Question
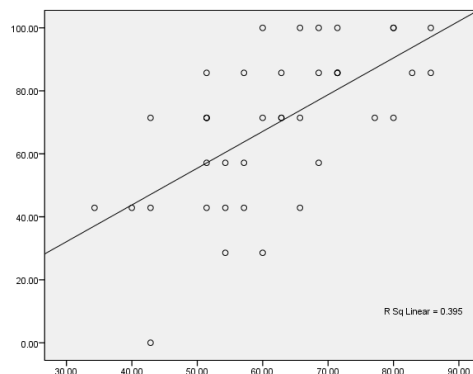
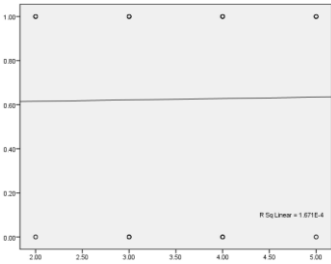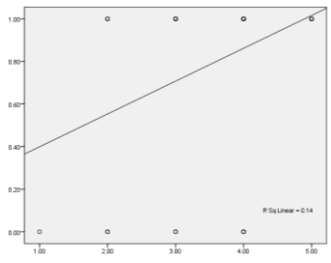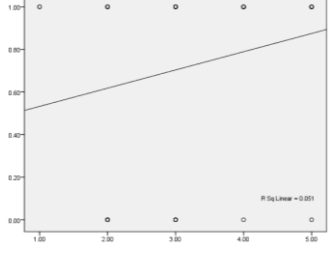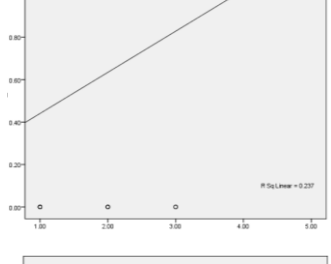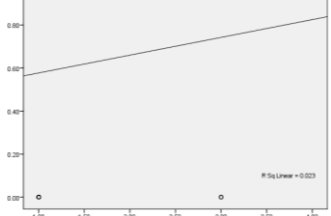**Figure 5**. Scatterplot of Post-test Score (*y-axis*) and CRI Score (*x-axis*)

A comprehensive understanding of how students' confidence levels relate to their answers on individual questions can be analyze from Figure 4. Those data became a valuable insights into the accuracy and certainty of students' responses, helping to identify patterns and areas where misconceptions or uncertainties may exist. Then a visual analysis of correlation between confidence levels and students' scores can be done using scatterplot in Figure 5. By using the CRI approach and analyzing the data through Figures 4 and 5, researchers can delve deeper into students' understanding of Earth Sciences and gain valuable insights into the factors influencing their performance. This analysis can help identify areas that require further attention and provide valuable input for refining the mentoring approach, ultimately leading to improved preparation for science olympiads in the field of Earth Sciences.
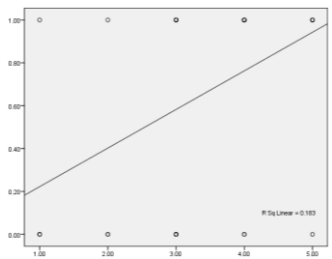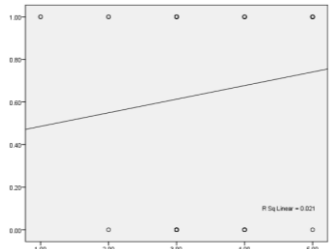
Overall, the analysis revealed a high correlation between students' answers and their level of confidence (CRI) when answering the test questions, with a Pearson correlation coefficient of $r = 0.628$ and a significant value of 0.000. This indicates a statistically significant correlation. However, to gain a deeper understanding of the correlation between post-test answers and the level of confidence for each student, further investigations was done using appropriate tests. The test results for each student shown in Table 2. For data that meet parametric assumptions (i.e., normal distribution and continuous variables), Pearson

correlation can be applied. For data that do not meet parametric assumptions (e.g., ordinal data or non-normally distributed data), Spearman's rho is more suitable.

Table 2. Correlation of Post-Test Scores and CRI of Each Student

Student	Scatterplot of Post-test Score (*y-axis*) and CRI Score (*x-axis*) of Each Student	Correlation Test	
		Pearson Correlation (sig. (2-tailed))	**Spearman's rho (sig. (2-tailed))**
A		**0.013 (0.937)**	0.014 (0.932)
B		0.374 (0.017)	**0.335 (0.034)**
C		0.226 (0.161)	**0.245 (0.128)**
D		0.487 (0.001)	**0.489 (0.001)**
E		0.152 (0.349)	**0.179 (0.270)**

Student	Scatterplot of Post-test Score (*y-axis*) and CRI Score (*x-axis*) of Each Student	Correlation Test	
		Pearson Correlation (sig. (2-tailed))	Spearman's rho (sig. (2-tailed))
F		**0.428** **(0.006)**	0.431 (0.005)
G		**0.146** **(0.368)**	0.197 (0.223)

*Note: The value of the correlation coefficient used is a bold number, depending on whether the data is classified as parametric (Pearson Correlation) or not parametric (Spearman's rho)

By conducting individual correlation tests for each student, researchers can identify variations in the relationship between confidence levels and performance, helping to understand how individual differences may affect the outcomes. This level of analysis can lead to more tailored and targeted support for students with varying levels of confidence and performance, ultimately enhancing their preparation for science olympiads in the field of Earth Sciences.

Among all the correlation coefficients, only students B, D, and F showed a significant correlation between their post-test scores and their level of confidence. This conclusion is based on the significance level (2-tailed) being smaller than 0.05. Therefore, the correlation between the post-test scores of students A, C, E, and G and their level of confidence is not considered significant. The highest correlation coefficient (r) values were observed for students D, F, and B, respectively. The correlation for all three students can be classified as moderate. Student D, with an N-Gain score of 0.53, obtained a post-test score of 77.5 and with correlation coefficient of r = 0.489 with their confidence level when answering questions. Student F, with an N-Gain score of 0.37, achieved a post-test score of 65 and with a correlation coefficient of r = 0.431 with their confidence level when answering questions. Student B, with an N-Gain score of 0.53, obtained the highest post-test score of 80 and correlation coefficient of r = 0.335 with their confidence level when answering the questions. On the other hand, the lowest correlation was found in student A's answers, with a post-test score of 62.5 and an N-Gain score of 0.47. The correlation between their post-test score and confidence level was not significant.

Based on the obtained correlation values for each student, it can be concluded that the level of student confidence does not guarantee high post-test scores, although this pattern holds true for several students (D, F, and B). A unique finding is observed in the data of student C, where the post-test score is relatively high (72.50) and the N-Gain score is the

highest (0.58), yet the correlation with the level of confidence when answering the questions is not significant. This correlation discrepancy deserves further exploration to understand why this particular student's performance and confidence level do not show a significant relationship. Self-confidence is one of the important competencies in emotional intelligence (Goleman, 2006). It could be influenced by various factors, such as intrinsic motivation (Wulandari & Pranata, 2023), test-taking strategies or other individual differences that require more in-depth investigation.

Analysis of The Earth Science Standards Test in pre- and post-test

Questions from the standardized instrument, The Earth Science Standards Test, were used for the pre-test, while only a portion of these questions (17 out of the total) were included in the post-test, as indicated in Table 1. This approach was chosen to align the questions with the content covered in the Earth Science Olympiad. By analyzing the same set of questions in both the pre-test and post-test, the researchers aimed to assess the extent to which students' understanding improved using these standardized instruments. The detailed results of this analysis can be found in Table 3.

Table 3 provides the detailed results of this analysis, including the individual pre-test and post-test scores for each student, the N-Gain scores, and any observed improvements in performance. The table likely shows how each student responded to specific questions from The Earth Science Standards Test and how their knowledge and understanding improved over the course of the mentoring sessions. Detailed results also enable other educators and stakeholders to understand the impact of the mentoring program and its implications for enhancing students' readiness for science olympiads in the field of Earth Sciences. The use of standardized instruments helps ensure consistency and reliability in the assessment process, making the results more robust and valid. It also allows for comparisons with other studies and helps place students' performance within a broader context, especially concerning Earth Science Olympiad preparation.

Table 3. The Earth Science Standards Test Questions in the Pre- and Post-Tests

Pre-test Question Number (Answer)	Answer Distribution in pre-test					number of students who answered correctly in pre-test (%)	Post-test Question Number (Answer)	Answer Distribution in post-test					number of students who answered correctly in post-test (%)	N-Gain Score
	A	B	C	D	E			A	B	C	D	E		
22 (C)	1	3	**2**	1	0	28.57	1 (C)	0	2	**3**	0	2	42.86	0.20
31 (D)	0	2	4	**0**	0	0.00	5 (B)	1	**5**	0	0	1	71.43	**0.71**
23 (D)	3	0	0	**3**	0	42.86	6 (A)	**3**	1	2	0	1	42.86	0.00
26 (A)	**3**	0	0	3	0	57.14	9 (A)	**6**	0	0	1	0	85.71	**0.67**
3 (B)	0	**5**	1	0	0	71.43	10 (C)	0	1	**5**	1	0	71.43	0.00
46 (C)	0	1	**3**	3	0	42.86	11 (C)	0	1	**5**	1	0	71.43	**0.50**
52 (D)	0	2	0	**5**	0	71.43	15 (E)	1	0	0	0	**6**	85.71	**0.50**
42 (D)	1	1	5	**0**	0	0.00	21 (C)	1	1	**3**	2	0	42.86	**0.43**
44 (D)	2	1	1	**3**	0	42.86	22 (A)	**4**	3	0	0	0	57.14	0.25
47 (D)	2	0	1	**4**	0	57.14	23 (D)	0	0	1	**5**	1	71.43	**0.33**
56 (D)	0	4	1	**2**	0	28.57	24 (D)	0	1	4	**2**	0	28.57	0.00
39 (A)	**4**	0	3	0	0	57.14	25 (C)	5	0	**0**	0	2	42.86	-0.33

Pre-test Question Number (Answer)	Answer Distribution in pre-test					number of students who answered correctly in pre-test (%)	Post-test Question Number (Answer)	Answer Distribution in post-test					number of students who answered correctly in post-test (%)	N-Gain Score
	A	B	C	D	E			A	B	C	D	E		
2 (C)	0	1	**4**	1	0	57.14	31 (B)	1	**6**	0	0	0	85.71	**0.67**
11 (C)	1	0	**3**	2	0	42.86	32 (D)	2	0	1	**4**	0	57.14	0.25
15 (B)	2	**4**	1	0	0	57.14	33 (A)	**5**	0	1	0	1	71.43	**0.33**
14 (A)	**5**	1	1	0	0	71.43	35 (C)	2	1	**3**	1	0	42.86	-1.00
5 (A)	**4**	1	1	1	0	57.14	40 (C)	0	2	**2**	3	0	28.57	-0.67
Average						46.22	Average						58.82	0.17

Based on the collected data and the analysis of student answers, scores, and N-Gain for each item, several important findings have emerged. These findings shed light on students' performance, misconceptions, and improvements in understanding Earth Sciences:

1. *Identification of Student Responses for Each Question.* The researchers were able to identify how students responded to each question, including all the questions in the standard instrument. Some questions, such as numbers 31 and 42, had no correct answers during the pre-test. This indicates that certain concepts may have been particularly challenging for students to grasp initially.

2. *Dominant Incorrect Answers.* The analysis revealed that some questions had dominant incorrect answers. For example, in question number 31, students predominantly chose options C and B as answers, while one student did not provide an answer. This suggests the presence of misconceptions or gaps in knowledge among students regarding specific Earth Sciences concepts.

3. *Improvement in Post-Test Scores.* The average post-test score (58.82) was higher than the pre-test score (46.22). This indicates an overall improvement in students' understanding of Earth Sciences concepts after participating in the mentoring sessions.

4. *Highest N-Gain Score for Question.* Post-test question number 5 showed a high N-Gain score, indicating a significant increase in students' understanding of the concept that geothermal energy is derived from magma as an energy source. This demonstrates the effectiveness of the mentoring sessions in enhancing students' comprehension of specific Earth Sciences topics.

5. *Persistent Misconceptions.* Despite the overall improvement, two students still answered question number 5 incorrectly during the post-test, with one choosing coal and the other choosing water as thermal energy sources. These misconceptions may require additional attention and targeted interventions to address

6. *Students' Answer Patterns.* The analysis depicted in Figure 6 illustrates that most students (four individuals) chose coal as the source of thermal energy during the pre-test, and one student still selected this option during the post-test. This consistent pattern of choosing coal as a thermal energy source suggests the presence of persistent misconceptions that need to be addressed.

Figure 6. Problem: (a) Pre-Test and (b) Post-Test

These findings highlight the importance of targeted support and interventions to address specific misconceptions and knowledge gaps in Earth Sciences. By understanding students' performance patterns and misconceptions, educators can design more effective mentoring sessions and learning strategies to enhance students' readiness for science olympiads in this field. Additionally, continuous assessment and tracking of student progress are crucial to monitor their growth and address any persistent misconceptions that may hinder their success in future assessments and competitions.

Despite the high improvement category (N-Gain), the level of students' confidence in answering this question was low, at 51.43%, as shown in Figure 4. However, overall confidence levels do not provide a detailed picture. To further support the analysis, the correlation between answers and the level of confidence for each student was examined, as presented in Table 2. The correlation between answers and the specific level of confidence for post-test item number 5 was also explored, as depicted in Figure 7.
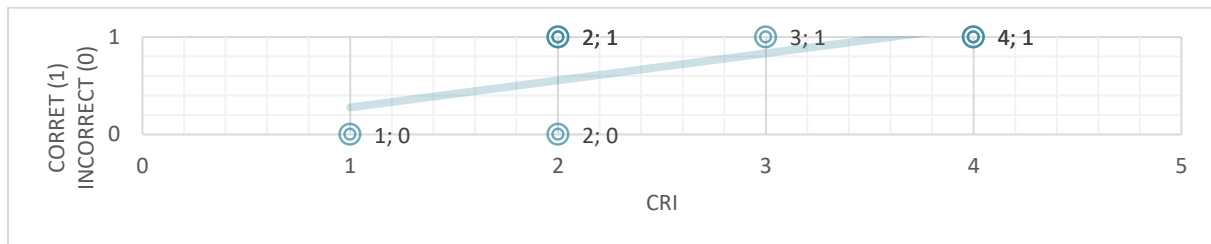
Figure 7. Correlation of Answers with Certainty of Response Index (CRI)

Furthermore, there were seven questions with a medium N-Gain score. Two questions, numbers 9 and 31, had N-Gain scores close to the high category, both at 0.67. These questions indicate a moderate (approaching high) increase in students' understanding of why and how earthquakes occur, as well as the scales used to measure their intensity and magnitude (question number 9), and the formulation of explanations using logic and evidence (question number 31). Lastly, eight questions had a low N-Gain score, including three questions with an N-Gain score of 0 and three questions with a negative N-Gain score. The question with the lowest N-Gain score (-1.00) was post-test question number 35, which pertained to the concept that the Sun is powered by nuclear reactions, primarily hydrogen fusion to form helium.

By examining the correlation between confidence levels and performance for specific questions, educators can gain a deeper understanding of how students' confidence impacts their ability to apply their knowledge effectively. This information can be used to design targeted interventions to boost students' confidence in answering challenging questions, thereby improving their overall performance in earth science olympiads.

In conclusion, a detailed examination of the correlation between confidence levels and performance on individual questions can provide valuable insights to enhance students' preparation and readiness for science olympiads. Identifying areas where students may lack confidence despite significant improvements in understanding can help educators tailor their support and build students' self-efficacy, ultimately contributing to their success in future academic and competitive endeavors.

Earth science education at the secondary school level requires more attention, especially in Indonesia (Amijaya, 2016). Earth science still not a main subject in secondary school, but included in geography. In contrast, other countries like Australia allocate a significant portion (25%) of their science curriculum to Earth and space science from Foundation to Year 10, and then offer Earth and Environmental Science at the senior level (Years 11 and 12) (Greco & Almberg, 2016). This highlights the importance of Earth science as a vital concept for students to learn in school. Earth Science is a vital concept for students to learn in school.

Competition, like science olympiad In Indonesia, play a crucial role in promoting Earth science education by motivating and inspiring students to learn more about the subject. These competitions provide an opportunity for students to engage in deeper learning and improve their overall capacity for Earth science education (Amijaya, 2016). Learning in the form of training and preparation for science olympiads can be an effective way for students to enhance their knowledge and understanding of Earth science concepts. Mentoring sessions, as shown in the study, can help students bridge their knowledge gaps and improve their performance in the competition.

Standardized tests, like the pre-test and post-test used in the study, are valuable assessment tools to evaluate students' prior knowledge before mentoring activities and measure the knowledge gains after the mentoring process. These tests provide valuable data for educators to understand students' strengths and weaknesses, identify misconceptions, and tailor their mentoring strategies to address specific needs.

By incorporating Earth science education in the curriculum and providing opportunities for students to participate in competitions and mentoring programs, educators can foster a greater interest and appreciation for Earth science among students. This approach can lead to a more informed and scientifically literate generation, better equipped to understand and address environmental challenges and contribute to sustainable development. Overall, investing in Earth science education and supporting science competitions like science olympiad in Indonesia can have a positive impact on students' learning experiences and contribute to the advancement of Earth science education in the country.

Conclusion

In conclusion, the study successfully utilized The Earth Science Standards Test as an appropriate tool to measure students' knowledge before and after participating in mentoring sessions for the Science Olympiad. The results indicated that students initially had relatively low knowledge of Earth science, which is understandable given that Earth science is not a separate subject in Indonesian schools. However, after the mentoring activities, there was a significant improvement in students' knowledge, as reflected in the higher post-test scores. The N-Gain scores further confirmed the moderate level of improvement achieved by most

students, except for one student who showed a decline in performance. This suggests that the mentoring sessions were generally effective in enhancing students' understanding of Earth science concepts.

Additionally, the correlation analysis revealed a significant relationship between students' answers and their level of confidence (CRI) when answering questions. However, this correlation was not consistent for all students, indicating that confidence levels do not always guarantee high post-test scores. Some students showed significant correlations between confidence and performance, while others did not.

Further research are recommended to better understand and address factors impacting students' performance and confidence in Earth Science Olympiad preparation. However, in this research, the application of the test was limited to the earth sciences. It is also recommended to extend the use of standardized tests to assess students' understanding in various science olympiad fields and subject in school learning. Expanding mentoring activities with comprehensive plans and strategies, such as collaborations between schools and universities, can further enhance students' preparation for science olympiads.

The Science Olympiad has the potential to trigger greater attention to Earth science education in Indonesia (Pranata, 2021a; Shankar, 2019). By using it as a tool, educational stakeholders can emphasize the importance of Earth science in the curriculum and promote its profile and quality. Furthermore, considering Earth science in a global context can be beneficial for Indonesian students, providing them with a broader perspective on environmental and geospatial issues. Developing standardized tests for learning science can also contribute to the overall improvement of science education in the country.

In summary, the study contributes valuable insights to the field of Earth science education and highlights the significance of science competitions like the Science Olympiad in motivating students to excel in various scientific disciplines. By addressing the gaps and enhancing students' readiness in Earth science, educators can foster a new generation of scientifically literate individuals, capable of tackling global challenges and contributing to sustainable development.

Credit Authorship Contribution Statement

Ogi Danika Pranata: conceptualization, methodology, resources, data collection, initial data analyzation, writing – original draft, writing – review & editing, supervision. **Nobel Marhsal**: software, visualization, formal analysis, resources, data analyzation, writing – review & editing, project administration.

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