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4Cs Skills in Ecology and Biodiversity Learning: A Study of Junior High School Students' Profiles in the Digital Era

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Abstract

Post-pandemic, gadgets have become an inseparable part of student life. This gives rise to brainrot which affects students' critical thinking and creative thinking skills. Gadgets also create an individualistic attitude, causing students to have difficulty communicating and collaborating. Seeing this challenge, students need to be equipped with Critical Thinking, Communication, Collaboration and Creativity (4Cs) skills. This research aims to determine the 4Cs profile of Pelita Nusantara Kasih Surakarta Christian Junior High School students in studying Ecology and Biodiversity. The research method used in this research is descriptive quantitative with multiple choice questions for critical thinking skills, a questionnaire for communication and collaboration skills, and essay questions for creative thinking skills. The research sample was class VII, VIII, and IX students with a total of 150 students as respondents. The sampling technique is cluster random sampling. Data collection techniques using questionnaires and tests. The results show that the critical thinking skills score is 74, the creative thinking skills score is 56, the collaboration skills score is 73, and the communication skills score is 66. The average 4Cs skills score for Pelita Nusantara Kasih Surakarta Christian Junior High School students is 67. The results of this research show that The 4Cs skills of Pelita Nusantara Kasih Surakarta Christian Junior High School students are in the medium category, but for the creative thinking skills need to be improved because they have the lowest score compared to other skills.

How to Cite

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INTRODUCTION

The digital era has brought about a major transformation in the learning process, including in ecology and biodiversity education. According to Liauw Toong Tjiek (2020), digital technology has become an inseparable part of students' lives in the modern era, especially after the COVID-19 pandemic. However, excessive use of gadgets can have negative impacts, such as brainrot, which according to Surbakti & Effendy (2023) can inhibit students' critical and creative thinking skills, and reduce their ability to communicate and collaborate effectively. Kurniasanti et al. (2019) also added that this impact is often accompanied by an individualistic attitude, which causes difficulties in students' social interactions, including cooperation in group-based learning.

However, a properly designed technology-based approach can be a very effective tool for developing 21st-century skills known as the 4Cs (Critical Thinking, Communication, Collaboration, and Creativity). Fitriyanti et al. (2021) emphasized that the 4C skills are very relevant in 21st-century learning, especially in supporting students to understand complex environmental issues. In ecology learning, critical thinking allows students to analyze the relationships between ecosystem components and evaluate the impact of human activities on biodiversity. This is in line with Zubaidah's opinion (2019), which states that critical thinking is key to preparing students to face global challenges. Creativity is also an important element, as explained by Redhana (2019), who stated that creativity can be trained through tasks that challenge students to design innovative solutions to environmental problems. In the context of collaboration, Khusna et al. (2023) stated that group work can improve students' social skills and enable them to utilize a diversity of ideas in completing tasks collectively. Communication, according to E. S. Anggraini (2021), is the main foundation in conveying ideas and opinions, both in group discussions and when presenting research results.

The urgency of this research lies in the importance of understanding the 4C skill profile of junior high school students in ecology and biodiversity learning. This study not only maps the level of student mastery of these skills but also provides strategic recommendations for teachers to design technology-based learning. This is in accordance with the opinion of Elizabeth Patras et al. (2024), who emphasized that digital technology can be a major supporter in integrating 4C skills into learning, so that students are able to become competent individuals who care about environmental sustainability.

Ecology is the study of how living things interact with their environment (Arman, 2021). Biodiversity Refers to the various types of life on Earth, including genes, species, and ecosystems (Yuliastrin et al., 2024). Ecology and biodiversity materials are important to learn in order to instill students' awareness and understanding of the interdependence between humans and nature and the impact of human actions on the environment (Moran, 2016). By understanding this material, students' sense of responsibility for environmental preservation can be built, while also motivating students to take part in maintaining the balance of the ecosystem in the future (Al-Mansoori & Hamdan, 2023). By studying ecology and biodiversity materials, we also learn about the various problems that occur on our earth (Yusliza et al., 2020). Examples of problems on our earth are climate change which causes global temperature to rise, melting of polar ice, and disruption of extreme weather patterns (Pecl et al., 2017). The loss of animal and plant habitats due to massive exploitation and environmental pollution causes species extinction (Prakash & Verma, 2022). In addition, deforestation and land degradation are also major problems for our earth, because they have an impact on reducing biodiversity, and disrupting the balance of nature which is important for the survival of all living things (Jayawardana et al., 2023).

Lailatul et al. (2024) stated that the purpose of learning ecology and biodiversity material in junior high school is for students to understand the relationship between living things and their environment, including the importance of preserving biodiversity. This learning is designed to raise students' environmental awareness and critical thinking skills in generating solutions to environmental issues (Jayadinata et al., 2024). Through project-based learning, students are expected to be able to identify environmental problems around them and propose creative, sustainable solutions in accordance with the values of the SDGs (Ludiya, 2024). In teaching ecology and biodiversity material at the junior high school level, teachers sometimes face several challenges such as students' lack of awareness of environmental issues which is influenced by students' lack of direct experience in observing the surrounding environment (Sikhosana, 2025). In addition, many schools experience limited learning resources, such as adequate laboratories or access to natural ecosystem locations (Ansya & Salsabilla, 2024). Another challenge is how to convey this

material in an interesting and relevant way so that students do not get bored, but are motivated to play an active role in environmental conservation (Syafitri Ardeliyani, Atariq Dery, 2023).

This research was conducted at Pelita Nusantara Kasih Surakarta Christian Junior High School because at this school, there has never been any measurement of students' 4Cs skills. So far, teachers have only focused on cognitive assessments of students. This is certainly not in accordance with the government's expectations to prepare students to face the 21st century. In addition to never having measured 4Cs skills at this school, the results of the 2024 Pelita Nusantara Kasih Surakarta Christian Junior High School Education Report Card show that the quality of learning is still relatively low, with a decrease of 1.41% compared to the results of the 2023 Education Report Card. In the sub-indicator of learning methods, which includes teaching practices to guide and support students in building new understanding or knowledge, this school scored 60.24 out of a maximum score of 100. The achievement of this indicator is measured through the average score in various aspects, namely adaptive instruction, teacher guidance, interactive activities, literacy learning, numeracy learning, and open learning climate scores obtained from the learning environment survey. The low achievement in these aspects indicates the need to measure students' 4Cs skills so that the results obtained can be used to design more adaptive learning and support students' learning needs in order to improve the overall quality of learning. The purpose of this study was to determine the 4Cs skill scores of students Pelita Nusantara Kasih Surakarta Christian Junior High School. By looking at the facts above, it is very important to conduct research on the analysis of the 4Cs skills of students at Pelita Nusantara Kasih Surakarta Christian Junior High School. The results of this study are expected to be information for schools in an effort to prepare students to face the challenges of the 21st century and in providing a basis for educational policy makers in formulating learning programs that are in accordance with the needs of the globalization era, as well as to determine learning models that are in accordance with school characteristics.

This study differs from previous studies by comprehensively revealing students' profiles through a digital-based approach, while also offering innovative learning strategies that are relevant to modern curricula. In addition, this article fills the research gap related to the adaptation of science learning to 21st century skills, providing new contributions to developing more contextual and skills-based science education.

METHOD

The research method used is quantitative descriptive because this study describes descriptively in the form of sentences according to the observed results, and conducts statistical measurements by calculating the 4Cs skill scores of students of Pelita Nusantara Kasih Surakarta Christian Junior High School. The subjects of the study was all students of Pelita Nusantara Kasih Surakarta Christian Junior High School with a total number of respondents of 150 students. This study was conducted on November 4-5, 2024 in the first semester of the 2024/2025 Academic Year. The research instruments are test and non-test instruments. The test instruments used are multiple choice questions and essay questions. The non-test instrument used is a questionnaire.

The technique of collecting critical thinking skills data is carried out by calculating the scores obtained by students when working on multiple choice questions, so that students' critical thinking skills scores are obtained.

Critical Thinking Skills = total score x 10

Table 1. Scoring of Correct and Incorrect Answers of Critical Thinking Skills by Students

Question Number	Robert Ennis Indicator	Students with the Correct Answer	Students with the Wrong Answer
1	Providing Simple Explanations	128	22
2	Building Basic Skills	123	27
3	Concluding	119	31
4	Providing Further Explanations	128	22
5	Setting Strategies or Tactics	92	58
6	Providing Simple Explanations	106	44
7	Building Basic Skills	119	31
8	Concluding	106	44
9	Providing Further Explanations	84	66
10		108	42

The technique of collecting creative thinking skills data is done by calculating the scores obtained by students when answering descriptive questions. Scoring guidelines are in the next para-

graph so students' creative thinking skills scores are obtained. Supporting data collection is done by documenting during the learning process.

$$\text{Result of Creative Thinking Skills} = \frac{\text{total score}}{0{,}16}$$

The assessment of students' creative thinking is based on William's indicator with four key indicators: Fluency, Flexibility, Originality, and Elaboration. Each indicator is evaluated using a specific question and scoring guidelines.

Fluency measures students' ability to generate numerous and diverse ideas. The stimulus: Biodiversity, encompassing flora, fauna, and ecosystems, is essential for maintaining ecological balance. However, threats such as habitat destruction, climate change, and over-exploitation endanger biodiversity, particularly in tropical rainforests like those in Indonesia.

Flexibility evaluates students' ability to present varied solutions by considering different perspectives. The stimulus: Indonesia has high biodiversity, including rainforests, coral reefs, and wetlands. These ecosystems are crucial for air, water, and soil quality, as well as wildlife habitats. However, threats such as illegal logging, pollution, and resource exploitation are damaging ecosystems and endangering species.

Originality assesses students' ability to create unique and uncommon ideas for addressing plastic waste problems. The stimulus: Plastic waste is a major environmental issue, taking centuries to decompose and polluting ecosystems. Millions of tons of plastic waste are produced daily, but only a small portion is recycled. While efforts have been made to reduce single-use plastics and improve waste management in Indonesia, challenges persist.

Elaboration measures students' ability to develop ideas in detail, explaining various aspects such as functionality, materials, application, and impact. The stimulus: Air pollution from vehicle emissions, factory smoke, and waste burning harms human health and contributes to climate change. It leads to respiratory diseases, heart conditions, and global warming. While solutions like tree planting and eco-friendly technology exist, further innovation is needed.

Data collection techniques to measure students' collaboration skills are carried out by calculating scores based on students' answers to the questionnaires given. For collaboration skills, the score is calculated by dividing the total score obtained by students by 0.06. This division is carried out to normalize the assessment results so that they reflect the level of mastery of communication and collaboration skills proportionally according to the indicators that have been set.

$$\text{Result of Collaboration Skills} = \frac{\text{total score}}{0.06}$$

The OECD-PISA collaboration skills indicator table consists of four main indicators, namely Effective Communication, Group Decision Making, Conflict Resolution, and Responsibility and Involvement in Groups. Each of these indicators reflects important aspects of teamwork, such as the ability to convey ideas clearly, contribute to joint decision-making, resolve conflicts constructively, and participate actively and responsibly in groups. To measure these collaboration skills, the indicator table includes 12 questions, where each indicator has three questions designed to assess an individual's ability in collaborative situations. The use of these indicators aims to provide a comprehensive picture of the extent to which a person can work together effectively in a group.The assessment of students' collaboration is based on OECD-PISA indicator with four key indicators: Effective Communication, Group Decision Making, Conflict Resolution, and Responsibility and Involvement. Each indicator is evaluated using a specific question and scoring guidelines.

Effective communication involves confidently expressing opinions on environmental issues while using polite and respectful language in discussions. It also requires actively listening to group members before responding to ensure constructive dialogue. In group decision-making, individuals should contribute to joint conservation plans, remain open to input from others when selecting actions, and avoid dismissing compromises as a waste of time. Conflict resolution skills include staying calm and composed during disagreements, seeking to understand different perspectives, and making an effort to find mutually beneficial solutions, even if not always successful. Lastly, responsibility and involvement in group work are demonstrated by completing tasks on time, ensuring all members have opportunities to participate, and helping peers understand biodiversity concepts.

Data collection techniques to measure students' communication skills are carried out by calculating scores based on students' answers to the questionnaires given. For communication skills, the score is calculated by dividing the total score obtained by students by 0.75. This division is carried out to normalize the assessment results so that they reflect the level of mastery of communication and collaboration skills proportionally according to the indicators that have been set.

$$\text{Result of Communication Skills} = \frac{\text{total score}}{0.75}$$

The assessment of students' communication skills is based on David Nunan's indicator with five key indicators: Comprehension of Information, Speaking, Listening, Reading, and Writing. Each indicator is evaluated using a specific question and scoring guidelines.

Comprehension of information involves the ability to understand explanations about ecosystems, whether from teachers or texts. A focused listener can grasp the importance of biodiversity, identify various ecosystems, and retain key information. In speaking, confidence plays a role in expressing opinions on environmental conservation. While some may struggle, clear articulation of ideas about environmental damage and the significance of biodiversity is essential.

Listening skills enable students to follow discussions about ecosystem threats and pollution, though some may find it challenging to keep up with arguments in group settings. Reading comprehension includes understanding ecological texts, interpreting diagrams, and recognizing the importance of biodiversity, though difficulties may arise with complex materials. Writing skills are demonstrated through the ability to summarize articles, report on local ecosystems, and describe human impacts on nature, although some may struggle to express ideas in their own words.

Descriptive data analysis is carried out on students' answers according to the scoring rubric that has been set and according to the category of critical thinking, communication, collaboration, and creative thinking skills. The time used to complete the written test is 90 minutes. The results of the assessment analysis then converted into a value with a range of 0 - 100.

Based on Equation 1, it shows that the value is directly proportional to the score obtained, if the score obtained by the student is high, the value obtained is also high, and vice versa. The results of the values obtained are then interpreted to determine the students' 4C skills which refer to the interpretation interval (Danaryanti & Lestari, 2018) which is presented in Table 2.

Table 2. 4C Skill Level Categories

Category	Interval
Very High	$81.25 < x < 100$
High	$71.5 < x < 81.25$
Medium	$62.5 < x < 71.5$
Low	$43.75 < x < 62.5$
Very Low	$0 < x < 43.75$

RESULT AND DISCUSSION

The results of this study were obtained from the analysis of multiple-choice questions for critical thinking skills, questionnaires for communication and collaboration skills, and essay questions for creative thinking skills given individually to the research sample. The results of the analysis of all questions and questionnaires were in the form of 4Cs skill scores for students of Pelita Nusantara Kasih Surakarta Christian Junior High School. Based on Table 2, the 4Cs skill score of Pelita Nusantara Kasih Surakarta Christian Junior High School students in critical thinking skills got a score of 74, creative thinking skills got a score of 56, collaboration skills with a score of 73, and communication skills with a score of 66, with the highest score being critical thinking.

Creative thinking abilities are included in the low category. While creative thinking skills obtained a score of 56 which is included in the low category. This is in accordance with the explanation of Danaryanti & Lestari (2018) that criteria with a score of 71.5 – 81.25 are included in the high category, scores of 62.5 – 71.5 are included in the medium category, while criteria with a score of 43.75 – 62.5 are included in the low category.

Table 3. 4C Skills of Students of Pelita Nusantara Kasih Surakarta Christian Junior High School

No.	Skills Measured	Category
1.	Critical Thinking	High
2.	Creative Thinking	Low
3.	Collaboration	High
4.	Communication	Medium
Average 4C Ability		Medium

Next, an analysis was carried out per indicator of critical thinking, communication, collaboration, and also creative thinking. The following is a discussion of each indicator in each skill.

Analysis of Critical Thinking Skills

Based on Table 4, the scores per indicator of critical thinking skills of Pelita Nusantara Kasih Surakarta Christian Junior High School students are included in the high category. The highest indicator is building basic skills with a score of 88 and the lowest skill is arranging strategies or tactics with a score of 64.

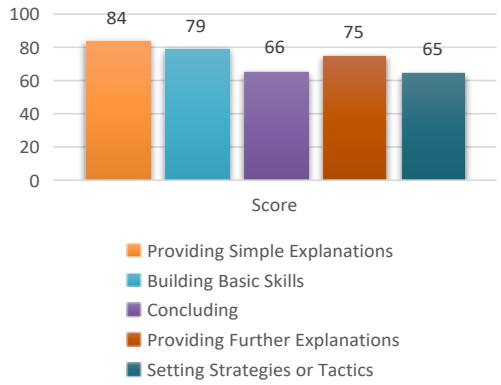

Figure 1. Critical Thinking Skills Per Indicator of Students of Pelita Nusantara Kasih Surakarta Christian Junior High School

The first indicator, namely providing a simple explanation, obtained a score of 84. This very high score indicates that students are able to understand the basic concepts of Ecology and Biodiversity. This is in accordance with the opinions of Fitriani et al. (2019); Ramdani et al. (2020); Setiana & Purwoko (2020), that students who have critical thinking skills are able to convey initial explanations well and can answer factual questions and explain concepts simply but accurately.

The second indicator, namely building basic skills, received a score of 79. This score is in the high category. This high score indicates students' ability to identify important information, analyze data, and use facts and concepts to solve simple problems related to biodiversity protection and observe data related to the impact of deforestation on animal populations. In accordance with the explanation of Indiana et al. (2024); Maqbullah et al. (2018); Maslakhatunni'mah et al. (2019), that students who have critical thinking skills are able to express their opinions.

The third indicator is concluding with a score of 66. The score on this indicator is classified as moderate, indicating that students still have difficulty drawing conclusions from more complex data or information. This difficulty may be caused by the complexity inherent in the data itself, the teaching methods used, and the development of reflective inquiry skills as conveyed by (Nurdyansyah & Fahyuni, 2016). Understanding these challenges is essential to improving educational strategies and improving students' analytical skills. According to Heller (2015), students' ability to conclude can be developed through inquiry learning.

The fourth indicator is providing further explanation with a score of 75. Similar to the second indicator, students show good ability in providing more in-depth explanations after receiving direction. Students have been able to link relevant concepts, although there are still limitations in terms of innovative thinking. According to Weber & Wilhelm (2024), this is influenced by students' initial abilities and students' interest in the theme.

The fifth indicator determines strategy or tactics with a score of 65. This score is in the medium category, the same as the third indicator. This shows that students are quite capable of designing strategic solutions or tactics related to forest conservation and animal populations in certain areas and also related to handling pollution problems, including the ability to design experiments, determine action priorities, or consider various alternatives. Research conducted by Arviani et al. (2023), shows that inquiry-based learning can significantly improve students' ability to organize strategies and tactics.

Table 4. Critical Thinking Skills Per Indicator of Students of Pelita Nusantara Kasih Surakarta Christian Junior High School

No	Critical Thinking Indicator	Category
1.	Providing Simple Explanations	Very High
2.	Building Basic Skills	Very High
3.	Concluding	Medium
4.	Providing Further Explanations	Very High
5.	Setting Strategies or Tactics	Medium

In general, the research results show that students have very good basic critical thinking skills in the first indicator, both in the second and fourth indicators, but still need strengthening in more complex indicators such as concluding (third indicator) and organizing strategies or tactics (fifth indicator). This indicates the need for a deeper and more applicable learning approach to encourage analytical understanding. Meanwhile, according to Thoyibah et al. (2022), we can improve students' critical thinking skills through collaborative activities.

Analysis of Creative Thinking Skills

Based on Table 5, the score per indicator of creative thinking skills of Pelita Nusantara Kasih Surakarta Christian Junior High School students is in the high category. The highest indicator is fluency and flexibility with a score of 69 and the lowest skill is originality with a score of 40.

Analysis of Creative Thinking Skills

Based on Table 5, the score per indicator of creative thinking skills of Pelita Nusantara Kasih Surakarta Christian Junior High School students is in the high category. The highest indicator is fluency and flexibility with a score of 69 and the lowest skill is originality with a score of 40.

Table 5. Creative Thinking Skills Per Indicator of Students of Pelita Nusantara Kasih Surakarta Christian Junior High School

No.	Indicators	Category
1.	Fluency	Medium
2.	Flexibility	Medium
3.	Originality	Very Low
4.	Elaboration	Low

In the study of measuring creative thinking, the instrument used according to William consists of four indicators, namely fluency, flexibility, originality, and elaboration. The creative thinking skills can be see Figure 2.

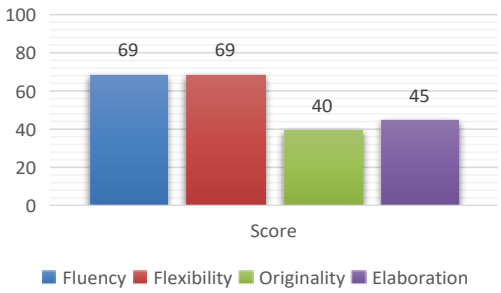

Figure 2. Creative Thinking Skills Per Indicator of Students of Pelita Nusantara Kasih Surakarta Christian Junior High School

The first indicator is fluency with a score of 69. This score indicates that students are quite good at generating many ideas in a limited time. In the context of ecological learning, students can provide several creative and relevant ideas related to real actions in maintaining and improving biodiversity in the environment, but there are some explanations that are not detailed enough or not all ideas for real actions that have a positive impact are explained well. According to Yusup et al. (2022), the results of analysis show that students with a high level of creative thinking tend to be able to provide more than one alternative answer.

The second indicator is flexibility with a score of 69. Students' ability to see a problem from various perspectives is also quite good. They are able to generate varied ideas and are able to see problems from various perspectives. For example, students can provide several solutions that vary and involve different parties, but there is one solution whose explanation is less detailed or its contribution to the preservation of biodiversity is less clear. The results of Basuki & Farhan (2023) study showed that flexible thinking has a significant influence on students' creative thinking skills.

The third indicator is originality with a score of 40. A low score on this indicator indicates that students have not been able to create unique and original ideas. The ideas expressed are not original, namely they are generated from common ideas. In addition, the explanation of the positive impact of ideas in overcoming the problem of plastic waste that was put forward was incomplete or less relevant. According to research conducted by Herdiawan et al., (2019), original ability can be improved through the Problem Based Learning (PBL) cooperative learning method.

The fourth indicator is elaboration with a score of 45. The ability to develop ideas in detail, explain various aspects of the idea, including how it works, the materials needed, the location of application, and its impact is also relatively low. Students seem to have difficulty expanding the ideas they produce with additional supporting information. For example, when asked to provide ideas in creating a tool or system that can help reduce air pollution in big cities, students provide less detailed explanations of the tool or system being designed. Some important parts such as how it works or the positive impacts are also not fully explained. The low score on this elaboration indicator is likely due to the varying levels of prior knowledge or cognitive abilities possessed by each student, so it is necessary to use differentiated learning methods to meet diverse learning needs, in line with the opinion of (Priawasana et al., 2020).

The creative thinking skills of students at Pelita Nusantara Kasih Surakarta Christian Junior High School in learning Ecology and Biodiversity are at a fairly good level for fluency and flexibility, but require more attention to originality and elaboration. Improving this ability can be done by providing more interactive, innovative, and real-problem-based learning so that students are more motivated to produce new ideas that are in-depth and applicable.

Analysis of Collaboration Skills

Based on Table 6, the scores per indicator of Collaboration Skills of Pelita Nusantara Kasih Surakarta Christian Junior High School students

are in the high category. The highest indicator is effective communication and group decision making with a score of 76 and the lowest indicator is conflict resolution with a score of 67.

Table 6. Collaboration Skills Per Indicator of Students of Pelita Nusantara Kasih Surakarta Christian Junior High School

No	OECD-PISA Indicator	Category
1.	Effective Communication	High
2.	Group Decision Making	High
3.	Conflict Resolution	Medium
4.	Responsibility and Involvement in Groups	Medium

In the collaboration measurement study, the instruments used are according to OECD-PISA, namely effective communication, group decision making, conflict resolution, and responsibility and involvement in groups. The creative thinking skills can be see Figure 3.

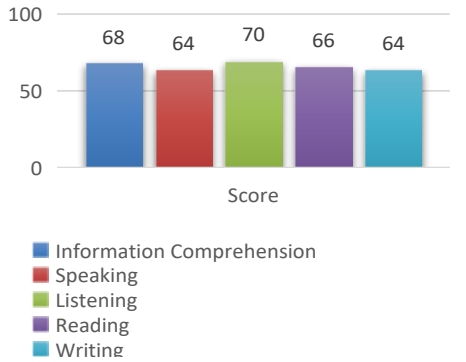

Figure 3. Communication Skills Per Indicator of Students of Pelita Nusantara Kasih Surakarta Christian Junior High School

In the communication measurement study, the instruments used are according to David Nunan, namely understanding information, speaking, listening, reading, and writing. The first indicator is understanding information with a score of 68. This score shows that students have a fairly good ability to understand the teacher's explanation about the ecosystem well and focus on capturing the main message when friends or teachers talk about the importance of preserving biodiversity. However, sometimes students are not able to identify various types of ecosystems through text or oral explanations. This may be due to limited vocabulary, which limits students' ability to understand and interpret texts effectively (Kharisma, 2019).

The second indicator is speaking with a score of 64. Students are quite capable of conveying their ideas clearly when discussing causes and impacts of environmental damage. Apart from that, students are also quite able to provide a brief explanation of why biodiversity is important for life. However, students have not shown confidence when expressing opinions about environmental conservation in class. This indicates need for guidance to improve more confident speaking skills. Huaixuan et al. (2024), involving students through peer tutoring will foster a collaborative learning environment that can increase students' self-confidence through shared experiences.

The third indicator is listening with a score of 70. Listening is the indicator with the highest score. Students show a fairly good ability to listen to the teacher's explanation about threats to the ecosystem without difficulty. Students are also quite capable of understanding friends' or teachers' explanations in group discussions about the impact of pollution on the environment. Apart from that, students are also quite capable of listening to and understanding other people's arguments regarding biodiversity. This ability is important in discussion-based and collaborative learning. However, students need to be trained to be more active in responding to the information they hear. According to Waloyo (2024), the teacher's teaching strategy greatly influences students in listening to lessons, for example by combining digital tools and applications so that it can improve students' listening practices.

The fourth indicator is reading with a score of 66. This reading score shows that students can adequately understand texts or articles that explain the importance of preserving biodiversity. However, students still have difficulty interpreting simple diagrams or graphs that describe ecosystem structure. However, students still have difficulty interpreting simple diagrams or graphs that depict the structure of the ecosystem. According to Iing Mustain (2015), one of the causes of students' difficulty in interpreting simple diagrams or graphs is the lack of basic knowledge in the subject matter, which hinders students' ability to interpret graphs accurately.

The fifth indicator is writing with a score of 64. In terms of writing, students are quite capable of writing short reports about the types of ecosystems around them using their own words. However, students still have difficulty in making summaries of articles or reading texts about biodiversity. The results of Hikmah (2022) research show that internal disturbances, such as boredom or lack of focus, can further complicate the process of summarizing for students. From this

explanation, students need to be accustomed to further practice in writing reports, essays, or summaries that are relevant to learning.

This research was carried out on all students at SMP Kristen Pelita Nusantara Kasih, with a focus on learning materials on ecology and biodiversity. This limitation was chosen to maintain consistency and depth of analysis in the context of science learning that is relevant to the development of 21st century skills. This study specifically measures students' 4C skills, namely critical thinking, creative thinking, collaboration, and communication skills. This focus aims to identify the profile of students' skills in solving problems, generating creative ideas, working effectively in groups, and conveying ideas clearly and precisely in learning based on ecology materials. Based on the results of this study, it is recommended that further research be focused on the development and implementation of a cooperative learning model based on STEAM (Science, Technology, Engineering, Arts, and Mathematics) that is integrated with the Sustainable Development Goals (SDGs). This model is believed to provide a holistic approach that not only improves students' 4C abilities—critical thinking, creative thinking, collaboration, and communication—but also equips them with insights into global issues such as climate change, environmental sustainability, and technological innovation. Further research can also explore the effectiveness of this learning model in various subject contexts, thereby making a significant contribution to improving the quality of 21st-century education, , such as the results of this study can help science teachers in designing learning strategies that integrate 4Cs skills in science learning, so that students can be more active in analyzing ecosystem relationships, environmental impacts, and biodiversity conservation efforts. In addition, the results of the study can also be used as a basis for developing digital-based learning models, such as the use of ecological simulations, online discussions, or investigation-based projects, which can improve understanding of concepts in greater depth. Thus, this study can help improve the quality of science learning in junior high schools to be more contextual, based on 21st century skills, and relevant to environmental challenges in the digital era.

CONCLUSION

The conclusion of this study is (1) Critical thinking skills are in the high category. The highest indicator is building basic skills, while the lowest indicator is setting strategies or tactics. (2) Students' communication skills are in the high category. The highest indicator is listening, while the lowest indicator is speaking. These results reflect listening skills. (3) Students' collaboration skills are in the high category. The effective communication indicator has the highest score, while the conflict resolution indicator has the lowest score. (4) Students' creative thinking skills are in the low category. The fluency and flexibility indicators have the highest scores, while originality has the lowest score. Overall, students' 4Cs skills at Pelita Nusantara Kasih Surakarta Christian Junior High School are in the good category, especially in critical thinking, communication, and collaboration, but creative thinking skills need to be improved. Suggestions for educators are that more innovative learning strategies need to be developed, such as project-based approaches (PBL), use of technology, and creative exploration Pelita Nusantara Kasih Surakarta Christian Junior High School to improve students' 4Cs skills. In addition, further research is needed on effective learning strategies to improve students' 4Cs skills.

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