

Students Perception of Citizen Science Contribution to Improving Scientific Argumentation Skills on Environmental Change and Sustainability Materials

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Received: December 26, 2024. Accepted: January 29, 2025. Published: March 11, 2025

Abstract: Citizen Science is a scientific research activity involving the community in research projects that aim to overcome daily life problems. Citizen Science can train 21st-century skills. Through Citizen Science, students will be trained to think critically and build scientific arguments based on data and evidence they collect independently. The presence of the 21st century is very important in training the skills that students in the 21st century must possess: communication skills, collaboration, critical thinking, and creative thinking. This study aims to describe students' perception of the role of Citizen Science in argumentation skills in learning biological materials, environmental change, and environmental sustainability. This type of research is descriptive qualitative research. Most students were interested in Citizen Science activities and found the project relevant to their daily lives. It also helped them improve their argumentation, critical thinking, and confidence skills.

Keywords: Argumentation Skills; Citizen Science; Students Perception.

Introduction

Citizen Science is a form of scientific research activity involving the community in research projects that aim to overcome daily life problems [1]. Citizen Science is citizen participation in scientific research through data collection and reporting [2]. Another definition explains that Citizen Science in scientific research has the potential to be a solution to overcoming social and scientific problems such as biodiversity and conservation [3]. Not only that, but the research conducted by [4] explained that citizen science involvement can train 21st-century skills. Incorporating Citizen Science in the world of education can help students be more concerned with knowledge and have skills that are in accordance with the needs of the times.

Along with the development of the times, the world of education is faced with a quite challenging situation. One of the big challenges faced is that education must produce competent human resources. The competencies expected to be possessed by human resources today are the competence to communicate and think. This means that human resources are expected to have extensive knowledge, be able to think creatively, be able to communicate in cooperation, and be able to think critically [5]. The presence of the 21st century is very important in training the skills that students in the 21st century must possess: communication skills, collaboration, critical thinking, and creative thinking [6]. Education in the current era requires students to have the skills needed in the 21st century, [7] said that four pillars are a reference for creating the skills needed in the 21st century. The four pillars are learning to know, learning to create, learning to live together, and learning to develop.

21st-century education in Indonesia faces challenges in improving four main competencies, namely creativity, critical thinking, collaboration, and communication, known

as the 4C (Creativity, Critical thinking, Collaboration, and Communication). These four competencies are very important for students to have so that they can compete in the future. One of the big challenges in education is finding ways to develop these four competencies in students. One of these important skills is effective communication [8]. The ability to communicate is a very important process in science learning and can help students achieve a deeper understanding [9].

Problems that arise in the current era, such as social and scientific problems, continue to develop. Irresponsible individuals often use these problems to spread untrue news or hoaxes. One way to overcome incorrect information-confirmation is to improve the ability to argue, which can be improved in school learning activities [10]. Argumentation skills are one of the skills needed in the 21st century. Argumentation skills are related to the ability to reason about information and involve problem-solving, making statements, and making decisions based on evidence and data [11].

In the 21st-century learning system, students are asked to be able to think critically, solve problems, collaborate and communicate [8]. In communication skills, argumentation skills convey students' opinions and ideas [12]. The learning process includes communication skills, where students can express their opinions on several problems. Expressing opinions is one ability that develops students' argumentation skills [13].

Toulmin first proposed the pattern of argumentation and the development of an argumentation framework as the basis for a theoretical perspective on arguments. Toulmin's argumentation pattern is used to analyze a familiar argument, namely TAP (Toulmin's Argument Pattern) [14]. Toulmin Argumentation has similarities to everyday argumentation to facilitate the task of analyzing various parts, especially by

How to Cite:

A. Agung, R. A. Mubaarak, R. Ramadani, and E. Roviati, "Students Perception of Citizen Science's Contribution in Improving Scientific Argumentation Skills on Environmental Change and Sustainability Materials", *J. Pijar.MIPA*, vol. 20, no. 2, pp. 207-211, Mar. 2025.
<https://doi.org/10.29303/jpm.v20i2.8277>

facilitating the conceptualization of the meaning of arguments, so that the Toulmin argumentation pattern is an argument pattern initiated by Toulmin in measuring and identifying the quality of a person's argument, makes a classification of 6 (six) important elements in an argument including claims, grounds, backing, qualifiers, warrants and rebuttals.

This learning model aims to train students' scientific argumentation skills using discussion. Because discussion can improve students' ability to argue scientifically, in this learning model, students who have an argumentative dialogue based on Toulmin's Argument Pattern (TAP) will develop their argumentation patterns from making claims, analyzing data and collecting, making justifications (warrants) and making supports (backing) to strengthen claims. The syntax of the model includes 5 stages, namely: (1) problem identification, (2) group argumentative discussions, (3) class argumentation discussion, (4) classroom mediation, and (5) knowledge integration. The dialogical argumentation learning model provides ample opportunities for students to argue, make claims or counter-claims supported by evidence to defend their stance or even raise a rebuttal to invalidate the claim. In this case, teachers play more roles as facilitators than knowledge suppliers for students. At the end of the lesson, a conclusion was made about the topic of the problem raised. That way, students can express their views freely, externalize their thoughts, erase doubts, and even change their minds if they are wrong [15].

Citizen Science is considered a way to improve the relationship between research, education, and action by involving non-professionals in scientific research. Through the Citizen Science Project, students will be trained to think critically and formulate scientific arguments based on data and evidence they have collected. It also allows students to participate in discussions requiring them to consider various perspectives in solving problems. Based on the description above, this study was conducted to describe students' perception of the role of Citizen Science on argumentation skills in learning biology material environmental change and environmental sustainability.

Research Methods

This descriptive qualitative research determines students' perception of Citizen Science's contribution to scientific argumentation skills about environmental change and sustainability. The method used in this study is descriptive, which aims to describe students' perception of Citizen Science's contribution to scientific argumentation skills. The population in this study is MA and SMA in the Cirebon City/Regency area. In contrast, the schools sampled in this study are class X from SMA Negeri 8 Cirebon City, SMA Negeri 1 Sumber and MA Salafiyah Cirebon City.

The data collection technique used in this study is a structured interview technique. According to [16], researchers have determined exactly what information to collect during the interview process using structured interview techniques. In addition to using structured interviews for data collection, researchers also used questionnaires to collect data. According to [17], questionnaires are a data collection technique that gives respondents a set of questions to answer. This questionnaire

is used to get students' perceptions of Citizen Science's contribution to argumentation skills.

Results and Discussion

The results of this study are divided into 2 segments, which are divided into interview results. Also, the results of a questionnaire distributed to Class X students from 3 high schools in Cirebon City consisting of SMAN 8 Cirebon City, SMAN 1 Sumber and MA Salafiyah Cirebon City regarding *Citizen Science*. The results of interviews regarding the question of citizenship terms to class X students in the three high schools/MA include that most of the students have never heard of it Citizen Science term. However, some students know about citizen science; they conclude that it involves community research to collect data. The data obtained from these community activities are data that have a beneficial nature in scientific activities.

In the next question regarding the experience of the involvement of class X students from 3 high schools and MA in the city of Cirebon for *Citizen Science* activities, it was found that most of the students had never participated in Citizen Science activities. However, they have a high interest in being able to participate in Citizen Science activities. One student knows one of the examples of *Citizen Science* activities and has participated in it. He admitted that he had carried out this activity to learn the biology of biodiversity material by observing the existence of flora and fauna in the surrounding environment. By carrying out this activity, he gained experience in collecting data on the existence of flora and fauna in the surrounding environment.

Most students in class X in the three high schools and MA in Cirebon City already know the benefits of Citizen Science activities. They said that Citizen Science can be involved in the world of education, especially regarding science. This is because the data obtained from Citizen Science activities will further deepen their knowledge of scientific events that occur in daily life. Most of them also said that Citizen Science could improve their argumentative skills. They will try to convey the results of the data that have been obtained by presenting their arguments at the conclusion stage.

Some of the students in class X in the three high schools and MA in the interview process also said that Citizen Science can be applied as one of the supporting components in biology learning, this is based on their assumption that the most appropriate material to combine with Citizen Science is a material based on Ecosystem, Biodiversity (Biodiversity), Bio-Ethnoscientific, and Biotechnology, where the material has the potential to be combined with Citizen Science activities in biology learning.

Furthermore, this study uses a questionnaire instrument that is distributed to students where the purpose is to analyze students' perception of Citizen Science's contribution to increasing scientific arguments, especially on environmental change and sustainability materials, this questionnaire instrument uses a Likert scale questionnaire 1-5 which includes four main aspects: perception of the Citizen Science project, Citizen Science's contribution on scientific argumentation skills, the use of data and information in argumentation, as well as the perception of material for change and environmental sustainability. The respondents were 15 grade X students from three schools: SMAN 1

Sumber, SMAN 8 Cirebon City, and MA Salafiyah Cirebon City.

On the question about the perception of Citizen Science, most students (73%) agreed that the Citizen Science project helped them understand environmental issues in depth, with details of 11 students agreeing, 2 students neutral, and 1 student each disagreeing and strongly agreeing., then as many as 40% of students strongly agree that this project motivates them to care about environmental sustainability issues. with details of 6 students agreeing, 5 strongly agreeing, and 4 neutral, then the majority of students (53%) feel that the material discussed is relevant to daily life, with details of 8 students agreeing, 6 neutral, and 1 strongly agreeing.

On the questions of Citizen Science's contribution to Scientific Argumentation Skills, most of the students (60%) agreed that this project helped them to formulate logical and structured arguments, with details of 9 students agreeing, 3 students strongly agreeing, and 3 students neutral, and as many as 60% of students agreeing that this project increases confidence in presenting scientific arguments, with details 9 students agreeing, 1 student strongly agreed, and 5 students were neutral.

In the question of the application of Citizen Science in the Use of data and information in argumentation, Most of the students (60%) agreed that they are used to using data from the Citizen Science project to support scientific arguments, with details of 9 students agreeing, 4 students neutral, and 1 student each disagreeing and strongly agreeing. A total of 66% of students agree that this project helps them understand how to use scientific information to build strong arguments, with details of 10 students agreeing, 3 neutral, and 2 strongly agreeing. As many as 60% of students agree that this project teaches how to distinguish scientific facts and opinions, with details of 9 students agreeing, 4 neutral, and 2 strongly agreeing.

Furthermore, the use of Citizen Science for learning obtained results in the form of 86% of students agreeing that the environmental sustainability material in the Citizen Science project encourages them to think critically, with details of 9 students agreeing, 4 students strongly agreeing, 1 student being neutral, and 1 student disagreed. Most of the students (53%) agreed that this project helped them relate learning to their daily lives, with details of 8 students agreeing, 4 students strongly agreeing, and 3 students neutral.

The results of interviews and questionnaires show that Citizen Science has great potential to improve students' scientific argumentation skills. Although most students are unfamiliar with Citizen Science, they are interested in participating in this activity. This approach provides a hands-on learning experience that allows students to integrate scientific data into their arguments. In this case, argumentation is central to education, especially science education, to make meaning and have an important effect on learning [18]. This is based on several opinions that state that students' involvement in scientific arguments can improve conceptual, epistemological, and methodological understanding of science [19] and support students enculturation into science practice [20].

As an illustration, *Figure 1* shows the interview process conducted with one of the students of class X at

SMAN 1 Sumber. In this interview, students explain how they view Citizen Science as an applied learning method.



Figure 1. Interview process
(Personal documentation, 2024)

Students who understand Citizen Science consider this activity useful in collecting scientific data that can be used to deepen knowledge related to scientific phenomena. This finding aligns with the statement of [21], which states that citizen science can bridge science with society and positively impact science education.

Most students know the benefits of citizen science in education, especially deepening their scientific understanding. This follows the statement from [22], which mentions that the involvement of a teacher, as a teacher, also needs to create a more engaging and meaningful learning environment, thereby increasing students' interest and helping them develop a better understanding of scientific concepts that are important for their future. They mentioned that this activity allows them to relate theoretical concepts to empirical data relevant to ecosystem-based materials, biodiversity, bio-ethnoscience, and biotechnology.

Citizen Science is also considered to be able to improve students' scientific argumentation skills. Students assessed that this activity trained them to analyze data, formulate logical arguments, and confidently present findings. This finding aligns with the research of [23], which stated that active participation in project-based activities can improve critical thinking and argumentative skills. However, this requires several other supporting factors, such as linguistic aspects and the relevance of using learning media with citizen science, which can influence the impact students will master [24].

The citizen science aspect can also support the psychological aspect of students, including 1) Being able to reflect on the reality of life, 2) Connecting various methods and things in society in the ability to find out, 3) involvement of social strengthening aspects that support the ability to explore information in the surrounding community, and 4) producing a transdisciplinary perspective that can create value based on the needs and desires of certain phenomena so that research objectives are more likely to be achieved comprehensively, validly, and reach the target group [25].

The questionnaire results showed that most students positively perceived Citizen Science, especially concerning environmental issues. 73% of students stated that the Citizen Science project helped them understand environmental issues more deeply. In comparison, 40% of students strongly agreed that this project motivated them to care about environmental sustainability issues.

As proof of support, *Figure 2* depicts the students' process of filling out the questionnaire at MA Salafiyah Cirebon City. This activity shows students' enthusiasm for providing their views regarding the relevance of citizen science to biology learning.



Figure 2. Questionnaire filling process
(Personal documentation, 2024)

Regarding scientific argumentation skills, most students (60%) agree that Citizen Science helps them construct logical and structured arguments. In addition, this project is also considered to be able to increase students' confidence in delivering scientific arguments. These results show that Citizen Science improves students' understanding of the material and strengthens their ability to convey ideas effectively.

The results also show that most students feel accustomed to using the data generated from the Citizen Science project as a basis to support their arguments. This process involves collecting data directly and processing that data into meaningful information in a scientific context.

Students' ability to integrate data into arguments suggests that Citizen Science-based learning approaches can practice higher-order thinking skills, such as analysis and synthesis. For example, students who participated in Citizen Science activities, such as biodiversity observations, said they could utilize flora and fauna data to support arguments about the importance of environmental conservation. This follows the principle of scientific argumentation, where data is an important element in supporting statements or claims [26].

Using scientific data to present arguments increases the accuracy of the information they convey and builds students' confidence in academic discussions. Thus, the Citizen Science project can be optimized as a learning method that combines theoretical and practical aspects to train students' argumentation skills, and using scientific data can develop the student research skills needed in 21st Century Skills [27].

The material on environmental change and sustainability, which is the focus of this study, is considered relevant to the students' daily lives. This follows the opinion of [28] that environmental change material is a material that has a lot of memorization and is related to daily life. Most students stated that issues related to environmental change, such as pollution, deforestation, and climate change, directly impact their lives and the surrounding environment. Citizen Science is an effective means of connecting biology learning with real issues. For example, students who have made observations of local ecosystems understand the importance of the relationship between human activities and their impact on environmental sustainability. This approach provides a real context that makes learning more meaningful, following the principles of contextual learning. This follows the statement of [29], which states that the contextual approach emphasizes providing real context in the learning process to improve students' understanding and its relevance to daily life.

In addition, the relevance of this material also increases students' motivation to participate in learning actively. When students realize their learning material has

direct application, they are more motivated to dig deeper into the information and engage in constructive discussions. This is in line with the view that the relevance of the material is an important factor in increasing students' interest and engagement in science learning [30]. Integrating environmental change and sustainability materials in the Citizen Science project allows students to understand the relationship between biological concepts and social issues. This reinforces the concepts learned and trains them to think critically and act as citizens who care about the environment.

Conclusion

Based on the research results, Citizen Science is proven to have great potential in improving students' scientific argumentation skills, especially in environmental change and sustainability. Although most students are unfamiliar with the term, they understand it as community involvement in scientific data collection. Most students were interested in Citizen Science activities, and they found the project relevant to their daily lives. It also helped them improve their argumentation, critical thinking, and confidence skills. Thus, integrating Citizen Science in biology learning can enrich students' learning experience, connect theory with practice, and develop important scientific skills, such as argumentation and data analysis.

Author's Contributions

Achmad Agung: Drafting the introduction. Raaqa Alfath Mubaarak: Developing the results and discussion. Rima Ramadani: Data analysis. Evi Roviati: Designing the research method.

Acknowledgements

The author would like to express his deepest gratitude to all parties who have supported and contributed to this research. Especially to the students at SMAN 8 Cirebon City, SMAN 1 Sumber, and MA Salafiyah Cirebon City who have participated in interviews and filled out questionnaires, as well as to the teachers and staff who have facilitated this research. The author also expressed gratitude to his supervisors and colleagues who provided valuable direction and input during this research process. Hopefully, this research will contribute significantly to developing biology learning and citizen science applications.

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