Exploring high school student’s argumentation structure through ecology: a case study

A Anisa*, A Widodo, R Riandi and M Muslim

1Student of Departemen of Science Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
2Departemen of Biology Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
3Departemen of Physic Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

*anisahendrayatno09@student.upi.edu

Abstract. Ecology is an important part of Biology that addresses all the interactions between living things and the environment. This case study research aims to reveal the structure of written and oral argumentation in grade X students in one of high school in West Java Indonesia on ecology. Research subjects were 42 students and 1 teacher with length of research for 2 months. The referenced argumentation pattern is by Toulmin's Argument Pattern (TAP). The results showed that students' written argument ability are in average structure of claim, data, and warrant pattern. The quality of written argument is quite good with the addition of counter-claim and rebuttal argument counterparts to a particular group in support of the claim. Oral argument capability also shows similar Toulmin's argument structure as written, with no additional structures of qualifier, counter-claim, and rebuttal. The comparison between the two shows that a higher quality is owned by a written argument.

1. Introduction

Ecology as the first basis in Biology that provides an understanding of the role of humans in the environment should be able to provide insight in overcoming problems related socio scientific issues. But in reality it has not been raised in the learning process through learning argumentation [1]. Learning through environmental (and ecological) materials can improve their ability to use classroom scientific arguments, but not many schools use argumentative approaches in their learning [2]. Argumentation has an important role in developing the ability of learners on aspects of critical thinking to collect various data in life to be concluded. The argument also encourages inquiry knowledge in understanding science using data and evidence so that the linkage between learners and the material context becomes awakened [3], [4], [5]. Arguments are often used as an important component in linking science education with an understanding of the content.

Biology, becomes one of the subjects in high school are used as one of a source for learners to be able to recognize themselves and the surrounding environment, and to solve problems in everyday life. Biology provides a variety of learning experiences to be able to understand science. Biology lessons provide direct emphasis on the learners to understand themselves as living beings and the natural surroundings using scientific principles. Ecology as part of Biology subjects have been introduced as
part of the material that can help unearth learners' abilities in analytical and critical thinking. The ecological concept taught in schools is one of education that aims to provide awareness and knowledge about the importance of the role of the environment in supporting life [6]. The complexes of ecological concepts such as food chains, food webs, bio geo-chemical cycles, food pyramids, and the role of biotic-abiotic components, require a learning process that leads students to think deeply and critically respond to the problems they encounter in daily life [7].

Mechanism of reasoning during the critical thinking about how to solve ecological problems can be measured by knowing the structure of arguments made by learners based on data and knowledge of science materials. This process of reasoning is still neglected by educators in measuring the success of learning. Educators rarely examine the use of arguments in measuring material understanding, so that critical thinking processes are not developed [8]. Data and facts supporting the power of argument are not only obtained for use in cognitive test measurements, but can be obtained by observing the phenomenon implicit in the material being studied. Based on the exposure, it was important to do case study to know the quality of the students' argument ability in understanding Ecosystem

2. Experimental method
The research design is qualitative research using case study approach. Case study is used to reveal description about the ability and the structure of written and oral argumentation of one teacher and 42 high school students grade X in West Java, Indonesia. The study lasted for 2 months. Data was taken using observation, video recording, interview, and open-ended essay test about ecology cases.

3. Result and discussion
3.1. The structure of written and oral argumentation
The quality of written and oral arguments measured consists of two subject matter; the Ecological Pyramid and Environmental Damage. Both are used to capture an integrative understanding of the issue of environmental damage associated with knowledge of the ecosystem. The analysis result of Toulmin's argument structure can be seen in Figure 1.

Figure 1. Written and oral argumentation structure on ecological pyramid and environmental damage.
As seen on figure 1, the written Toulmin’s argumentation structure dominated by claim (91.67%) and data (91.67%); followed by warrant 83.33%; backing 41.67%; counter claim 16.67%; and rebuttal 8.33%. The quality of oral argumentation results obtained as seen on figure 2 show the similar pattern as written arguments structures. 83% is dominated by claims, 75% by data and warrant, 42% backing, with no qualifier, counter-claim, and rebuttal.

3.2. A Comparison between written and oral argumentation structures
Toulmin divides the argument structure into two groups, the basic argumentation group consisting of claims, data, and warrants; and an advanced argumentation group consisting of backing, qualifier, and rebuttal. The counter-claim actually goes into the claim structure, but the claim is the opposite of the previously stated claim. Here are a comparison argumentation quality between written and oral arguments on ecological pyramid and environmental damage as seen on table 1.

| No. | Argumentation Structure | Written (%) | Oral (%) |
|-----|-------------------------|-------------|----------|
| 1   | Claim                   | 91.67       | 83.33    |
| 2   | Data                    | 91.67       | 75.00    |
| 3   | Warrant                 | 83.33       | 75.00    |
| 4   | Backing                 | 41.67       | 50.00    |
| 5   | Qualifier               | 0.00        | 0.00     |
| 6   | Counter-claim           | 16.67       | 0.00     |
| 7   | Rebuttal                | 8.33        | 0.00     |

Table 1 shows that written arguments have more heterogeneous structures than oral arguments. Written arguments have additional structure in TAP in the form of counter-claim and rebuttal. Learners more easily express opinions in the form of writing than oral. The results of interviews on 6 students (representing each group) showed that the written argumentation their expressed to respond about the environment damage cases will not instantly get rebut or reject by other groups as well as when they orally argued. It’s mean that, they had an opportunity to think over the claim and data while wrote the arguments.

3.3. The quality comparison between written and oral argumentation on ecology subject
One of the environmental damage issues raised is about the destruction of forests to open the oil palm plantation by showing figure 2 to the students. Students are asked to provide scientific arguments about the positive and negative things that are caused.

![Figure 2. Environmental issues on the ecology subject.](image-url)
The qualities of written and oral argumentation students during the Ecology class are shown in Table 2. It shows an interesting result, that in average, 50% of students is in the adequate quality of oral argumentation instead written argumentation. Other result show in figure 3 that 16.7% students written argumentation quality are in good category, and none are found in orals’.

Table 2. The quality of written & oral argumentation on two ecological subjects.

| Argumentation Quality | Written Argumentation (%) | Oral Argumentation (%) |
|-----------------------|---------------------------|------------------------|
|                       | ED* | EP* | ED* | EP* |
| Very Good             | 0   | 0   | 0   | 0   |
| Good                  | 16.67| 16.67| 0   | 0   |
| Adequate              | 33.33| 33.33| 33.33| 66.67|
| Less                  | 33.33| 33.33| 50.00| 0   |
| Basic                 | 16.67| 0   | 16.67| 16.67|
| None                  | 16.67| 16.67| 0   | 16.67|

*ED = Environmental Damage; EP = Ecology Pyramids

As seen on table 2, there is a difference in the percentage among groups in the argumentation that the learner learns in the sub-matter of environmental damage and the ecological pyramid between written and oral arguments. The quality to argue in written form actually still can be improved if students have the opportunity and time to correct their written argument [9]. During the case study observation, teacher have insufficient time in exploring the complexity of written and oral argumentation of students, so that the instruction can not fully build the students ability to conduct a scientific argument.

The result of this study have the similar result with the research conducted by Metaxan and Ekanara [10], [11]. Metaxan [10] reveal that the argumentation in writing and oral still follow the claim, warrant, and backing pattern. It’s understandable that how students can have a high complexity of argument structures if their teachers don’t own it yet and never give an argument-based teaching instruction. Ekanara [11] research showed that only 9.1% of students who have argumentative ability with argument structure consist of claim, warrant, backing, and qualifier, the rest of 90% student are in the quality of the basic argument, which consists only claims, warrants, qualifier, or less.

The interview conducted on students, teacher, and vice principals indicate that in term, they do not understand well enough about the importance of argumentation ability in learning process. Teachers who teach Biology in grade X actually see the students’ limitation in critical thinking, but have not been able to correct the learning process. The learning processes are still in teacher centre system, so the students have small opportunity to develop their skills to gain the knowledge and understanding in Biology by them self.

Oral arguments process that attempted in this study show that students are not used to expressing opinions. Some students do exist that are orally active, but their perspectives often do not fit the context and ecological content being given at the time. Teacher tend to immediately provide feedback in the form to answers to the questions of students, it also seems to be determinant the lack of complexity of the argument structure held by students. Students are generally seemed unsure of what they express and look reluctant to argue. They said it was hard to tell some argument if it based on data, and they end up with some undefined claim. Similar result shown by Muslim [12] during the first treatment on physical class, but as time goes by the argumentation instruction, the result came to success.

4. Conclusion
The structure and quality of written argumentation in the learning of Ecosystem subject in grade X shows that more than 50% of Toulmin's argument structure still consists of claim, data and warrant. The quality of argument is quite good with the addition of counter-claim and rebuttal argument structures in a particular group in support of the claim their expresses. The Structure and quality of
oral argument in learning material of Ecosystem in class X shows that as well as written, more than 50% of Toulmin’s argument structure still consists of claim, data and warrant with percentage distribution between all three tend to be evenly distributed without additional structures in the form of qualifier, counter-claim, and rebuttal. Comparison of structure and quality of argumentation between written and oral shows better tendency on written argument with higher quality distribution of 16.67% on good criteria consisting of claim structure, data, warrant, counter-claim and rebuttal. Oral arguments are mostly in less quality with the argument structure consisting of claim, data, and warrant.

**Acknowledgments**

Researchers would like to thank to all participant who has helped carry out the research.

**References**

[1] Rundgren S C and Rundgren C 2010 SEE-SEP : From a separate to a holistic view of socioscientific issues Asia-Pacific Forum Sci. Learn. Teach 11 pp 1–24

[2] Aleixandre M P J 2007 Designing Argumentation Learning Environments in Argumentation in Science Education Springer pp 91–115

[3] Horng R Y, Lu P H, Chen P H and Hou S H 2013 The effects of argument stance on scientific knowledge inquiry skills Int. J. Sci. Educ 35 no 16 pp 2784–2800

[4] Cetin P S 2014 Explicit argumentation instruction to facilitate conceptual understanding and argumentation skills Res. Sci. Technol. Educ. 32 no 1 pp 1–20

[5] Suminar L, Muslim and Liliawati W 2017 Integrated argument-based inquiry with multiple representation approach to promote scientific argumentation skill

[6] Jordan R, Gray S, Demeter M, Lui L, Hmelo-silver C E, Jordan R, Gray S and Demeter M 2009 An Assessment of Students’ Understanding of Ecosystem Concepts : Conflating Ecological Systems and Cycles Appl. Environ. Educ. Commun 8 no 1 pp 40–48

[7] Özkan O, Tekkaya C and Geban O 2004 Facilitating conceptual change in students’ understanding of ecological concepts J. Sci. Educ. Technol. vol 13 no 1 pp 95–106

[8] Bathgate M, Crowell A, Schunn C, Cannady M, and Dorph R 2015 The Learning Benefits of Being Willing and Able to Engage in Scientific Argumentation Int. J. Sci. Educ. 37 pp 1590–1612

[9] Chen Y C, Hand B and Park S 2016 Examining Elementary Students’ Development of Oral and Written Argumentation Practices Through Argument-Based Inquiry Sci. Educ. 25 pp 277–320

[10] Metaxas N, Potari D and Zachariades T 2016 Analysis of a teacher’s pedagogical arguments using Toulmin’s model and argumentation schemes Educ. Stud. Math. 93 pp 383–397

[11] Ekanara H B, Rustaman N Y 2016 Studi tentang Keterampilan Pembentukan Klaim mengenai Isu Sosio-Saintifik Siswa Menengah atas pada Kelompok Budaya Sunda Biodaktika 11 pp 21–45

[12] Muslim 2015 Implementasi Model Pembelajaran Argumentasi Dialogis dalam Pembelajaran Fisika untuk Meningkatkan Kemampuan Argumentasi Ilmiah Siswa SMA J. Penelit. dan Pengemb. Pendidik. Fis. 1 pp 13–18