Constructing Scientific Argumentation in Inquiry Based Reading : Frameworks for Analyzing Argument Process in the Classroom

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ABSTRACT

The purpose of this study was to investigate the impact of inquiry-based reading on students' argumentation skills and how scientific argumentation was constructed in science classroom communication. In this classroom research, 59 students of Biology Education Program at a state university in Central Java, who were at their third semester, participated in the inquiry-based reading for 10 weeks. The data were qualitatively and descriptively analyzed in search of ways that could describe the observed changes in students' performance on argumentative process and argumentation product. Argumentation process illustrated how they stated claim, found evidence, formulated reasoning, defended their argument, questioned and evaluated other's claim. The results showed that students' argumentative skills related to their understanding of problem context and the argumentation products increase as they experienced in inquiry based reading. The study describes empirical facts of how scientific argumentation is built as part of inquiry in inquiry-based reading and implication for future research.

Keywords: inquiry, reading, scientific argumentation, teaching strategy

1 INTRODUCTION

Scientific argumentation is an important part in science education for a number of reasons, namely: 1) to enable students to easily gain knowledge and understand the nature of science as a branch of study (van Emeren, et al., 2014) & (Ryu , 2012); 2) to be part of scientific inquiry and literacy (Erduran, Ozdem, & Jee, 2015); 3) to be an important aspect in the practice of scientific language use in class (McDonald, 2017); 4) to give significant contribution to the formation and development of quality written arguments (Sampson & Clark, 2011); 5) to develop and resolve socio-cognitive conflicts through logical and structured way which leads to change of concept (Nussbaum, Sinatra, & Owens, 2012). Further, Azvedo, Martalock, & Kesler (2015) state that the performance of scientific argumentation in science classes can be influenced by activities and classroom discourse within the class, including the interaction between teacher and students, as well as by the learning model and design. There are several categories of scientific argumentation performance based on its quality, namely: 1) Level 1, argumentation which contrasts between two different claims, 2) Level 2, argument which contrasts between a claim from another claim which includes data, warrants or backings but rebuttals; 3) Level 3, argument which contrasts among a set of claims or counter-claims which include data, warrants, or backings with weak rebuttals; 4) Level 4, representing argument with clear claims and rebuttals, which include a number of claims and counter-claims; and 5) Level 5, representing argument with more than one rebuttal.

What has happened in science classes is that practicing to learn about argumentation has not been paid enough attention to because of teachers' assumption that to put forward an argument means to reason, while students' reasoning is shown by their ability to give reasons why it happens so to their answers or statements. This assumption is in fact contradictory to what argumentation defines, as what has been suggested by Toulmin (1958, 2003), that an argument is constructed by a set of: 1) claims, 2) data, 3) warrants to tie claims and data together, 4) backings to support warrants, dan 5) rebuttals to refute data, facts or logics used, and 6) qualifiers to show the quality of the obtained conclusion.

The paper aims at further analyzing activities that teacher and students implemented in inquiry learning in science class, which enable students' scientific argumentation skills to maximally develop. The problem to discuss in the study lies on how the process of scientific argumentation occurs. The main focus of the study is the framework design, lesson plans, scientific argumentation process, and teacher role. The study is expected to provide information on the design of inquiry learning and which learning activities and strategies prove to enhance students' scientific argumentation skills.

1.1 Reading as Inquiry

Scientific reading is different from popular or fiction reading. A person is said to comprehend a scientific passage if he can obtain information from the passage and acquire knowledge from the passage into his mind based on what the author intends to deliver. The level of knowledge obtained from the activity will vary; however, a scientific passage is considered to be of quality if it can provide information and knowledge to all of its readers (Cao, Tian, Dezhi, Liu & Sun, 2015). It is not easy to comprehend a scientific passage, because readers sometimes have to locate the important parts of the text, make notes or even make a diagram or concept map to understand its content more (Guerrero & Ramos, 2015). It is this part of reading activity which can be categorized into inquiry activity.

1.2 Scientific Argumentation in Inquiry Learning

Argumentation is often compared to the ability to debate in order to search for truth, to overcome bias, to make decision out of options, to resolve conflicts, to exchange knowledge and so on (Schwarz, 2009). In learning process in science classes, those activities are often neglected due to several reasons. The majority of science teachers who were interviewed for the research stated the difficulty in teaching argumentation because they had limited allocated time, tools, and equipment, and teacher and students were just not ready. Findings from the field revealed that the low level of students' argumentative skills was also caused by inappropriate use of scientific language; in fact, the synergy between scientific literacy and language literacy contributes significantly to the argumentative skills and the expected level of achieved performance of scientific concepts (Bradbury, 2014;Seah, 2016).

2 MATERIALS AND METHODS

Participants of the research were 59 students from Biology Education Program of a state university in Central Java who were in their third semester. Students were distributed purposively into experimental group and control group. The experimental group were taught using inquiry-based reading, whereas the control group were taught using project based learning. Data were collected through observation from the implementation of inquiry-based reading. The first two learning sessions were used to inform and familiarize students about the basics of reading scientific references and ways how to choose trusted literature. The next eight sessions were used to implement the inquiry-based learning by giving tasks to students to analyze problems related to topics of morfo-anatomy adaptation of plants in different habitats. Each of the students wrote a scientific passage and presented their ideas in a class discussion using poster show case. Argumentation was assessed on the scientific passage that they wrote, poster show case and how they maintained ideas, asked questions and debate others' opinions. The aspects of argumentation were assessed based on Toulmin's Argument Pattern (Toulmin, 2003), namely how to state claims, find evidence, formulate reasoning, defend arguments, question, and evaluate others' claims. Data were descriptively and qualitatively analyzed to obtain findings on how argumentation process occurred, how students responded, and what problems students encountered.

3 RESULTS AND DISCUSSION

Research results revealed that after they were trained on how to select appropriate literature and how to cite references, it showed that most of the students referred to Adapted Primary Literature (APL), followed by textbooks, Journalistic Reported Version (JRV) and Primary Science Literature (PSL) as their main sources of references. Articles in PSL are usually written by scientists for other scientists; they are dominated by argumentative writings, especially provided with evidences and arguments to support conclusion. This type of genre is commonly found in many reputable scientific journals. APL has similar characteristics to PSL, but the articles are not commonly written by scientists who conducted their own researches. Articles of this kind can be found in reviews of researches and are generally addressed to students of science. Therefore, in spite of its use of argumentative texts, APL uses relatively more readable language than PSL. Textbooks are generally used by students as a scientific means of communication in education system, are written by science educators or science authors, which contain more facts than evidences to support conclusions. JRV also has similar characteristics to textbooks, which contains fewer evidences to support conclusions, but articles from JRV are usually published in scientific magazines (Yarden, Norris & Phillips, 2015).

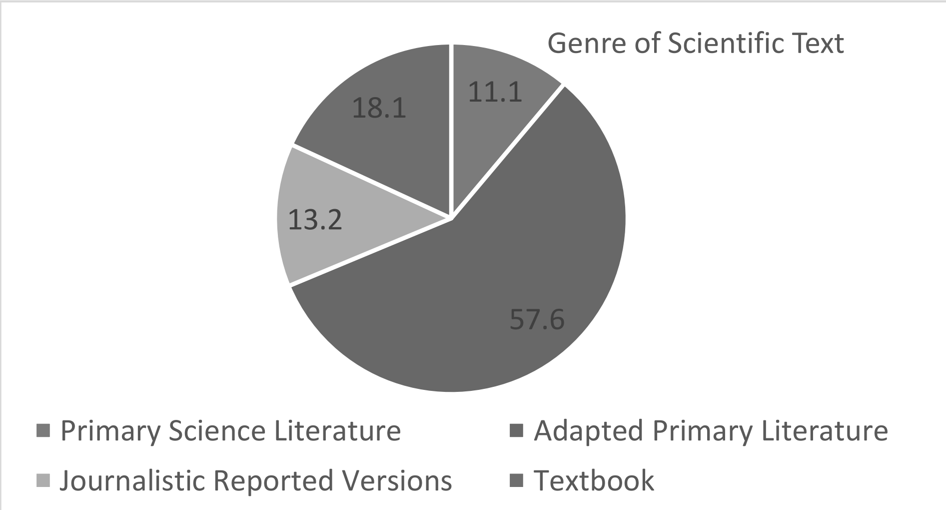

Figure 1. Types of scientific reading materials for students' references in accomplishing tasks

It was found out in the research that the types of reference which students took influenced the quality of argumentation they presented, both orally and written. Students who referred from PSL and APL performed more solid rebuttals and backings than those who referred only from textbooks or JRV.

Argumentation process was observed from the beginning when students started to write papers based on review of literature and their experiences when doing experiments. Students' studiousness in preparing argumentative materials was also shown by the kind of references they used to write the papers. Students who referred their papers from PSL and APL scientific articles performed better written argumentative skills than those who referred only from APL or other combined types of references. This finding makes sense, because the article genres from both PSL and APL contained more complete aspects of argumentation when compared to those from the other resources, especially in terms of data, evidence and reasoning. Thus, students who read the articles carefully could reflect themselves as if they had been the scientists, with their critical thoughts, who conducted the researches and presented their ideas.

The role of the teacher, in the inquiry-based reading, was to monitor students' activities in observing and obtaining the necessary data. Besides, she also made some necessary notes required to improve classroom discourse. Some of the notes were inserted in the following figure.

Review Presentasi Jaringan Tumbuhan

Kelas B, 21 September 2016

1. Pertanyaan mhsw banyak yg tidak terfokus pada anatomi (misal, topik meristem nanas, pertanyaan malah mengapa nanas mengakibatkan keguguran), enzim yg diperlukan pada kultur jaringan tumbuhan
2. Kesulitan mahasiswa untuk mengembangkan materi secara sistematis, dari yg sederhana ke kompleks
3. Media MMT banyak yang belum standar
4. Presenter banyak yang meninggalkan konsep dasar, langsung ke aplikatif (tidak ada scaffolding).
5. Kesulitan membedakan opini dan teori, data dengan fakta

SARAN KE PENGAMPU / PELAKSANAAN:

1. Pengampu menjelaskan terlebih dahulu konsep meristem pada tumbuhan,supaya mahasiswa memiliki pengetahuan dasar sama sehingga ketika mendapatkan materi pengembangan (kultur jaringan) sudah memiliki pengetahuan awal.
2. Diberi bekal teori tentang pembuatan media yang komunikatif, mudah dipahami, tulisan terbaca dalam jarak 3 m.
3. Ada insentif perlengkapan, dan media.
4. Tersedia papan untuk memasang MMT
5. Disediakan alat tunjuk (tuding/ pointer)
6. Perekam ditambah/atau, merekam secara tuntas setiap kelompok (10 menit), sehingga pengampu dapat merievew materi yang dijelaskan oleh presenter.
7. Catatan Presenter:
   a. Presenter 1, an. M Ikhsan ➔ * Tulisan dalam media MMT teralalu kecil,

Figure 2. Teacher's daily notes in inquiry-based reading

The teaching procedures in the inquiry-based reading were implemented through a set of activities, namely collecting and recording data through reading, constructing data through reading, processing, creating, sharing results through window system, and evaluating. Every learning session in class was dominated by presentation and class discussion. Students' argumentative skills were then assessed by Toulmin's Argumentation Pattern (Toulmin, 2003), both orally and written. The results of assessment were presented in the following figure.

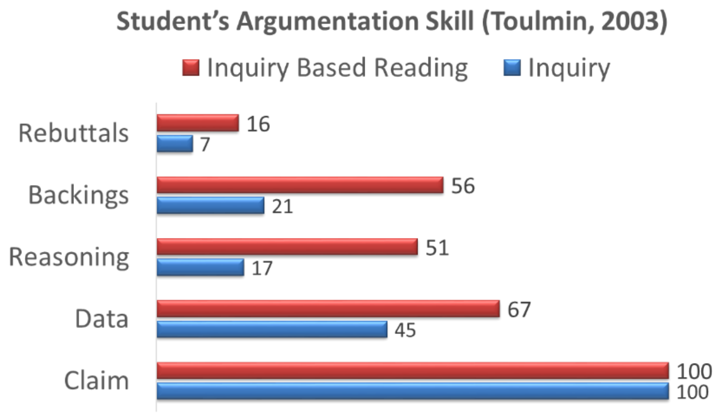

Figure 3. Average of Students' Argumentative Skills

The above figure shows that students taught using inquiry-based reading performed better in developing their argumentative skills, compared to those taught using only inquiry-based learning. This happened because the inquiry practices in science learning will be more meaningful if students have sufficient prior knowledge; in this case, the practices are done through reading appropriate scientific texts that can support scientific literacy (Wright, Franks, Li, McTigue, & Serrano, 2016). Nevertheless, it is worth to admit that it is not easy to embed scientific reading habits before starting the teaching learning process, and it requires much concentration, because the language of science is sometimes different from the language of science classroom instruction (Phillips & Norris, 2009). Furthermore, some other findings of the research include issues of how to motivate students to overcome problems in reading activity, such as limited language competence, accurate reference citation habituation, and integration of inquiry through reading and its utilization to strengthen appropriate argumentation aspects. Teacher could also exploit the uniqueness of students' personal characters to formulate learning strategies that can stimulate inquiry-based reading, because some of the students showed increased affective factor after they formed and discussed in study groups that they found comfortable and enjoyable.

4 CONCLUSION

The research results showed that students' argumentative skills related to their understanding of problem context and the argumentation products increase as they experienced in inquiry-based reading. The study describes empirical facts of how scientific argumentation is built as part of inquiry in inquiry-based reading and implication for future research.

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