Argumentation Quality of Socio-scientific Issue between High School Students and Postgraduate Students about Cancer

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Abstract. Argumentation is one factor that can help improve critical thinking skills. Arguing means to defend statements with the various data, denials, evidence, and reinforcement that support the statement. The research aimed to capture the quality of argument skills by students in grade 12 high school students and in postgraduate student on social-scientific issues of cancer. Both group subjects are not in the same school or institution, chosen purposively with the subject of 39 high school students of grade 12 in one district of West Java and 13 students of Biology education postgraduate in one of University in West Java - Indonesia. The results of the quality structure of arguments in both subject groups show the same pattern, which is claim - warrant - and ground, with the quality of counterclaim aspects on the postgraduate students look better than grade 12 students. This provides an illustration that the ability in argumentation between students and teachers in the socio-scientific issue of cancer should be evaluate so that the learning process would be more refined in schools.

1. Introduction

Learning is the process of interaction between learners and teachers as educators using every learning resources. Learning is a conscious and planned effort so that learners can gain meaningful learning experiences. Standards of science learning, especially Genetics in Biology, provide a learning experience for understanding the concepts of heredity, genes, chromosomes, and their relationship to protein synthesis. Socio scientific issue about cancer are often raised as a theme that always interesting to discuss. Cancer is a disease that often causes the sufferer to die if not get a serious and immediate treatment. Cancer has struck people in varying degrees of age, and has an increased risk tendency with age [1]. Early prevention and diagnosis of cancer can increase the survival rate of the patient and may even cause the patient to recover from his cancer. Cancer can be defined as a disease in which abnormal cells grow malignant (uncontrolled division) by crashing into normal cell division rules.

Normal cells will signal when it's time to divide, differentiate and even signal when the age of the cell has been completed. The cancer cells develop have their own signals that can not be recognized by
the system of the body resulting in cell division and proliferation that can not be controlled. If division and proliferation is malignant and spreads it will cause cancer, until the metastasis phase [2].

Argumentation has an important role in developing the ability of learners on aspects of critical thinking to collect various data in life and be concluded. Arguments also encourage inquiry knowledge in understanding science using data and evidence so that the linkage between learners with the material context becomes construed [3] Arguments are often used as an important component in linking science education with an understanding of the content of the material [4].

Argumentation is seen as the center of co-ordinating theory and evidence in a case to make a conclusion [5], [6] think critically and decide the problem so that the development of social responsibility can be done appropriately [7]–[10] understand about science in a better way [6], [7], well interaction with subject in science [11], literacy intelligence [12], constructing scientific reasoning [6], [15], helps students understand contextually [14], Able to independently question, criticize, reinforce opinion using strong and accurate evidence, make appropriate judgments so as to accept differences in knowledge in all areas that correlate with ethical and social issues [10].

Mechanism of reasoning can be measured by knowing the structure of arguments made by learners based on data and knowledge about science materials. This reasoning is often overlooked by educators in measuring the goal of learners. Educators rarely examine the use of arguments in measuring material understanding, so that critical thinking processes are not built. In addition to critical thinking, by looking at the quality of argumentation, educators can see various ways of social view of learners in developing various phenomena of data and facts found when learning science [15].

Data and facts that strengthen the argument are not only obtained for use in cognitive test measurements, but can be obtained by observing the phenomenon that implicit in the material being studied. Melissa Schen [11] revealed that there is no significant difference between undergraduate students who are in elementary level with undergraduate students who are in higher level in the same Department of Biology in making scientific argumentation. The reasoning ability shows a weak correlation (Spearman’s rank correlation, r=0.282, p=0.000), Especially in undergraduate students who are at the 400th grade level. The study also showed a weak ability to dig up other data that can be used as a counterclaim with a rebuttal that can actually make a statement that has made it become stronger.

Students in the grade 12 of High School class in the department of science and mathematics obtain a field of study in a wide range of genetics, including the basic of genetic substance - genes, DNA, and chromosomes; And advanced genetics include protein synthesis, mutations, Mendel heredity, heredity disorders, biotechnology, and evolution [16]. The depth of subject on the undergraduate students majoring in Biology on genetics (in the Department of Biology of education and non-education) is given specifically to the genetics and molecular genetics courses, then for postgraduate students was the development of socioscientific studies on Biotechnology.

Several studies have shown that a high percentage of first-year biology students do not understand the concepts of gene models and gene expression [16]. Other parts of the material subject that exist in the genetic material contextually generate much public attention because it gives an ethical impact that encourages the decision making to resolve the pros cons of arising [17]. This debate that can give learners to express their views on whether to support the situation in certain contextual cases or to give rejection. This will help learners develop their judgment with proper justification [17]. The lack of research on socio scientific issue about cancer of learners at various levels formal education, especially those in postgraduate students, encourages the research to know the use of content in genetics as well as in a comprehensive application (such in social, ethical, and scientific aspects) through the socio-context Scientifically are used in arguments.

2. Method
The research method are used case study research with two groups of subject. First group are students of grade 12 in one of high school in west java, age range between 14 - 15 years, with 10 male students and 31 female students. The second group are 13 postgraduate students in first semester of Biology Department of Education in one of university in west java, Indonesia, age range between 25 – 33 years
and these 13 subject work as a teacher of Biology in high school in various regions in western Java. Research subject in the study were choose by purposive sampling. The argumentation is adapted from Toulmin’s argumentation pattern, that contain the structured argument by Claim, Grounds, Warrant, Backing, Qualifier, Rebuttal, and counter-argument (CoC).

Instruments given are questions in the socio-scientific issue context of the cause of cancer in humans are by inherited genetic abnormalities or a lifestyle that can trigger the cancer to grow. The research phase consists of preparation phase, implementation phase, data analysis phase, and data interpretation stage.

**Preparation stage**, instrument making to measure the structure of argumentation using context of socio-scientific issue about cancer. Repaired 3 times by using expertise validity assessment; **The Implementation Phase**, (a) instruments given in both subject groups are conducted outside of classroom learning; (b) interviewing the subject about the difficulties in Biology subjects; and (c) Analysing the collected data results; **Stage of Data Analysis**, Data analysis of structure quality of argument first by qualitative then transformed into quantitative form; and **Data Interpretation Stage**, the results of the analysis is then interpreted in the form of case study report.

3. **Result and Discussion**

3.1. **The quality of argumentation structure of grade 12 high school students**

The results of the structure of Toulmin’s argumentation in figure 1, related to socio-scientific issues about cancer showed that 37 students or 94.87% stated claims, 34 people or 87.18% stated grounds, 18 people or 46.15% proposed warrant Between grounds and claims, 1 person or 2.56% suggests backing (claim support), and 10 or 25.64% represents counterclaim. The general pattern that emerges from the data in figure 1 is the Claim - Ground - Warrant (CGW) argument as much as 22 people or 56.41% and the remaining 43.59% is a combination pattern of C - G - B or C - G - B or C - G - W - CoC or any combination of the five argumentation structures. Figure 1 can more clearly illustrate the components of Toulmin's argumentation structure of the grade 12 high school students.

![Figure 1](image-url)

**Figure 1.** The Argument structure achieved by grade 12 Student

3.2. **The quality of argumentation structure of postgraduate students**

The quality of argumentation structure of postgraduate student in socio scientific issue about cancer can be seen in figure 2. The results of the structure of Toulmin’s argumentation in figure 2 related to socio-scientific issues about cancer showed that 13 post graduate students or 100% stated claims, 8 students or 61.54% stated grounds, 6 students or 46.15% stated warrant between grounds and claim, 2 students or 15.38% stated backing (support claim), and 3 student or 30.77% express counterclaim (statement of opposite). The general pattern that emerged from the data in figure 2 is the Claim - Ground - Warrant (CGW) argument pattern of 6 students or 46.15% and the remaining 53.85% is a
combination pattern of C - G - B or C - G - B or C - G - W - CoC or a combination of the five-argumentation structures.

Figure 2. The Argument structure achieved by Postgraduate Students

Comparison of Toulmin’s argumentation structure between postgraduate students majoring in Biology education with grade 12 high school students majoring in science can be seen on figure 3.

Figure 3. Comparison of Toulmin’s argumentation structure between post graduate students with grade 12 high school students.

Figure 3 shows that a claim or argument statement, followed by ground or data supporting to the proposed claim, dominates by those two arguments structure in both groups. 94.87% claim stated only followed by 87.18% ground then between ground and claim, 46.45% of which followed by warrant or justification that strengthens claim based on evidence. Only 2.56% in the group of grade 12 high school who follow warrant with backing. Overall, it can be seen that the pattern of quality argumentation of high school students of grade 12 of science majors is a claim-ground-warrant pattern (CGW).

The same pattern of argument can be seen in the quality of the argumentation of postgraduate students majoring in Biology Education. 92.31% claim that appears only followed by 61.54% ground and 46.15% warrant. The CGW pattern does seen in the group of postgraduate students. But the differences are in the percentage of backings and counterclaims are higher in postgraduate students. Postgraduate students are better to express counterclaim to strengthen their claim. An example of an argument that includes 4 argument structures can be seen on subject B for postgraduate student and subject number 38 for grade 12 high school student in figure 4 and figure 5.
Both results show the similarity with the research by Metaxas.N, et al., 2016 which states that in general, the argumentation in writing and verbal still follow the pattern of claim, warrant, and backing[18]. Other research suggests that university-level learning activities, showing more arguments related to biotechnology content and ethical issues concerning human life and the environment, are due to the basic knowledge of biotechnology has become common subjects, both by students and even by their own teachers [19]. That is why in the group of postgraduate students, the quality of the argument on the structure of counterclaim is better than grade 12 high school students.

**Figure 4.** The argument structure of subject B has a pattern Claim, Warrant, Backing & Counterclaim

Subject B (Postgraduate) in Figure 4 said that “Basically every individual has the potential to get cancer, have relatives of cancer or not. It is possible that this cancer is a combination of several causes, not just genetic. Plus the carcinogenic substances assist in the growth of cancer cells. Although a person has a kin sufferer's for cancer, if there is no trigger in to it (e.g. a mutation caused by carcinogens), then the individual will have less probability affected by cancer”.

**Figure 5.** The argument structure of subject 38 has a pattern Claim, Warrant, Backing & Counterclaim

Subject 38 (grade 12) in Figure 5 said, “Breast cancer causing factors are actually influenced by heredity (e.g. family history), environment, chemicals, and so forth. Why are many cases caused by non-genetic factors? Because I think more and more women who smoke, who choose instant food, the amount of pollution, and the depletion of ozone so that direct exposure to sunlight. So that breast cancer can be appear. Because there is only a few of us recently who maintaining a healthy diet on their lifestyle.”

Two of the sample shown a similarities argument, it mentions that cancer can caused by multiple risk, heredity and bad habitual life style. The claims followed by warrant and backing, but in the end, both arguments claim that lifestyle it self can make the cancer arise on someone.
From two samples, we would not think that both are from subjects who have different levels of education. There is no reinforcement in biological contents in subject B that suggests he or she is more familiar with genetic, biology cell or other biological subjects that more deeply explores the specific causes of cancer. Both arguments seem to be talking about the same thing in different sentences.

Interviews conducted after written argumentation test, it’s apparent that subject B is a long-standing Biology teacher teaching in junior high school, and now currently a home schooling teacher of grade 11 and grade 12 students. The curriculum in junior high school does not specifically address the material understanding of biology cell subject and genetics subject. Biology was taught thematically, integrated with physical and chemical subjects. Although subject B is graduated from university, but because his/her teaching does not provide the challenge to keep trained to maintain an understanding of the depth of biological material, it is very likely he/she forgot to use it in arguing. In addition, subject B when the research is held, he/she was on first semester student of post graduate, so the advance courses on genetics and cell biology have not been received.

Subject 38 at the time of the interview was held he/she said that she/he found that subject about heredity in Mendelian are the hardest subject among other biology subjects, mean that he/she has no difficulty in other biology subjects. The written argument presented looks no different in terms of content with postgraduate student. Subject 38 during research was studying the genetic material of Mendelian laws, so his/her knowledge of genetics should be still fresh in his/her memory. His/her argument does not provide specific data about it to strengthen the reason why cancer is arisen. It can be understood because biology cell was taught at grade 11 in high school so that the subject 38 probably forgot about the subjects or even not understand it during the class.

One of the problems in education is the lack of integration of each biological subjects. At the time the teacher taught, there was no apperception that connected the previous subjects with the next ones, so that the students did not get the correlation between one to another. The student thought that the material they were learning was not something related to the previous material. Not only students get the wrong interpretation about the connection between lots of Biology subjects, it also affects the habits of teaching and educating, so that the teacher was finally forgotten, that any given material connected to one or several things with other biological materials.

The same results revealed that science knowledge is not a variable affecting the quality of argumentation [17], as well as research results Pinar Seda Cetin (2015)[4] which suggests that the quality of socio scientific arguments produced by under graduate teachers is not significant influenced by their content knowledge.

It becomes important to develop more research to identify the exact cause of the similar result of Toulmin’s argumentation structure among student from lowest to higher - level education. The result of these studies in the future can be used as a reference on how to improve best the quality of argumentation content and the complexity of the argument structure in learning at various levels of education.

4. Conclusion
In general, the quality of argumentation patterns in both groups shows the same pattern of claim - warrant - ground, and in the group of postgraduate students majoring in Biology education the quality of argumentation on the aspect of counterclaim looks better.

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