Analysis of students critical thinking skills in socio-scientific issues of biodiversity subject

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Abstract. Critical thinking is a skill which the students should have in order to face 21st century demands. Critical thinking skills can help people in facing their daily problems, especially problems related to science. This research is aimed to analyze students critical thinking skills in socio-scientific issues of biodiversity subject. The method used in this research was descriptive method. The research subject is first-grade students in senior high school. The data collected by interview and open-ended question which classified based on framework: (1) question at issue, (2) information (3) purpose (4) concepts (5) assumptions, (6) point of view, (7) interpretation and inference, and (8) implication and consequences, then it will be assessed using rubrics. The result of the data showed students critical thinking skills in socio-scientific issues of biodiversity subject is in low and medium category. Therefore we need a learning activity that is able to develop student's critical thinking skills, especially regarding issues of social science.

1. Introduction

In the 21st century as the era of globalization, education should be able to prepare the students in order to have a skill in facing the future. The demand of people mindset changes in the 21st century is to create education that can produce human resources. That human resources is expected to build social and economy order and aware about national education. Besides, it is also expected huge changes in national education. Some abilities that students need to have are thinking critically, creatively, and innovatively, collaboration and communication skills [1]. Roommates Scheme is developed by P21 is explained by adding core subject 3R. In education context, 3R means collaboration and communication capabilities [1]. Scheme developed by P21 clarified with the additional cores subject 3R in the context of education, 3R stands for reading, writing and arithmetic. To clarify the function core subject 3R within the context of 21st century skills, the 3R translated into life and career skills, learning and innovation skills and information media and technology skills [1].

UNESCO has declared that education should be directed to: 1) Interdisciplinary and holistic learning rather than subject-based learning; 2) values and critical thinking base rather than rote learning, and 3) Involve decision [2]. In this case the student as a man of the future, prepared to skillfully take a role in the problems associated socio-scientific. Therefore, any scientific study, it should be able to connect the concepts of science (scientific) in the social problems that occur in the environment. With the use of
social-scientific problems in learning, will enhance students' understanding of science concepts related to values and other sciences [2].

The theme used in this study is biodiversity. Today the issues related to the issue of biodiversity is becoming a concern as the environment changes. Biological diversity issues very closely to the daily lives of students that are expected to spur the students to use their skills in critical thinking. Environmental issues often contain values, ill-defined and controversial, so involvement in the issue socio-scientific trigger students to apply the concepts, principles and practice of science on the issue is also influenced by considerations of social, political, ethical and economic [3].

The issue of social science is a representation of the issues or problems in social life which is conceptually closely related to science [4] with a solution that answers relative or uncertain [5]. The issue of social science refers to the social issues related to science dilemmas conceptual, procedural and technology [6]. The issue of social science can be found in the global context, such as the issue of genetic engineering (gene therapy, cloning or stem cells) and environmental problems such as global warming and climate change [6]. The issue of social science in the lift in this research is issues related to biodiversity, such as conservation of mangroves and coral reefs, as well as the conservation of some endangered animals.

The variety of life on Earth, its biological diversity is commonly referred to as biodiversity. The number of species of plants, animals, and microorganisms, the enormous diversity of genes in these species, the different ecosystems on the planet, such as deserts, rainforests and coral reefs are all part of a biologically diverse Earth. Appropriate conservation and sustainable development strategies attempt to recognize this as being integral to any approach to preserving biodiversity. Almost all cultures have their roots in our biological diversity in some way or form. Declining biodiversity is therefore a concern for many reasons.

Biodiversity boosts ecosystem productivity where each species have an important role to play. A healthy biodiversity provides a number of natural services for everyone. Example of ecosystem services is protection of water resources, soils formation and protection, nutrient storage and recycling, pollution breakdown and absorption, contribution to climate stability, maintenance of ecosystems, recovery from unpredictable events. Biological resources, such as food, medicinal resources and pharmaceutical drugs, wood products, ornamental plants, breeding stocks, population reservoirs, future resources, diversity in genes, species and ecosystems. Social benefits, such as research, education and monitoring, recreation and tourism, and cultural values [7]. That is quite a lot of services we get for free. The cost of replacing these would be extremely expensive. It therefore makes economic and development sense to move towards sustainability. Genetic diversity helps to prevent the chances of extinction in the wild and claims to have shown proof of this. To prevent the well-known and well documented problems of genetic defects caused by in-breeding, species need a variety of genes to ensure successful survival. Without this, the chances of extinction increases. And as we start destroying, reducing and isolating habitats, the chances for interaction from species with a large gene pool decreases.

2. Methods
The method used was descriptive method. Biodiversity subject was used in the research class. In order to collecting the data, the researcher observed the biodiversity in school environments. Involved Research subject is 37 students from first-grade students' senior high school in school in Subang. Instrument used in this research is interview. The teacher was interviewed about teaching learning. Then, open-ended question which is based on socio-scientific issues about biodiversity had been classified based on the framework developed by [8]. The indicators that have been measured are:
Table 1. Indicators of critical thinking

| Elements of Critical Thinking | Indicators |
|-------------------------------|------------|
| Question at issue             | Students are able to make inquiries based on the phenomenon or data |
| Information                   | a. Describing something based on data or information |
|                               | b. formulate things based on information provided |
| Purpose                       | a. Formulate objectives |
|                               | b. Describe the function / benefits / role something |
| Concept                       | Explain the concept |
| Assumptions                   | Making assumptions |
| Points of View                | Creating a viewpoint on anything |
| Interpretation and Inference  | Making the interpretation of a thing |
|                               | Make conclusions about something |
| Implication and Consequences  | Explaining the implications and consequences of a case |

The critical thinking analysed from the students' answers with the following formula:

\[
\text{value of students} (\%) = \frac{\text{score acquisition}}{\text{score maximum}} \times 100\% \tag{1}
\]

The percentage value critical thinking skills then obtained from the calculation then categorized according to the following table:

Table 2. Category of critical thinking skills percentage

| Percentage (%) | Category |
|----------------|----------|
| 81.25 <X ≤ 100| Very high|
| 71.5 <X ≤ 81.25| High |
| 62.5 <X ≤ 71.5| Average|
| 43.75 <X ≤ 62.5| Low |
| 0 <X ≤ 43.75 | Very Low |

3. Results and Discussion

3.1. Critical thinking skills of students per indicator

Table 3 data obtained from the study were analyzed and categorized the level of critical thinking skills on each indicator. Here is the percentage of the results of the categorization of critical thinking skills of each indicator.

Table 3. Data critical thinking skills of students each indicator

| Indicator           | X    | Score max | Score min | Sd.  | Percentage | Category |
|---------------------|------|-----------|-----------|------|------------|----------|
| Question at issue   | 1.21 | 3         | 0         | 0.71 | 41%        | Very Low |
| Information         | 1.30 | 2         | 0         | 0.70 | 65%        | Average  |
| Purpose             | 0.92 | 2         | 0         | 0.92 | 46%        | Low      |
| Concept             | 1.49 | 3         | 0         | 0.84 | 50%        | Low      |
| Assumptions         | 1.49 | 2         | 0         | 0.65 | 74%        | High     |
| Points of view      | 1.54 | 3         | 0         | 0.65 | 51%        | Low      |
Based on Table 3 can be explained that the level of critical thinking skills in each indicator is not the same. Level critical thinking skills of students categorized as very low for the question at issue, the moderate category for information, the low category for the purpose, the low category for the concept, high category for the assumptions, the low category for points of view, the medium category for interpretation and inference, as well as the category being for implication and consequences. Here is the percentage of students' critical thinking skills per indicator in social issues in the materials science of biodiversity.

![Figure 1. Percentage of critical thinking skills of students each indicators](image)

**Indicator:**
1. Question at issues
2. Information
3. Purpose
4. Concept
5. Assumptions
6. Points of views
7. Interpretation and inference

**3.1.1. Question at issue.** Based on Table 4, the average score obtained by the student in question at issue indicator was 1.21 with 41% that can be answered correctly by students. Critical thinking skills in the indicator question at issue into the category of very low [7]. The expected answer questions that students make a question linked two variables contained in articles but students tend to make the a question which two variables that are required that were asked to have not associated or only mentions one variable. Even, some student make a statement not make a question. Judging from the answers that students give to this indicator, the students do not understand the direction the questions asked yet.

**3.1.2. Information.** Based on Table 4, the average score of students on information obtained is 1.30 to 65% that can be answered correctly by students. Critical thinking skills in the indicator information into the category of being [7]. Answer expected that students provide 3 information related to a given article. Of the total number of students, there are 16 students who are able to answer in accordance with what was requested. The rest is to provide information, but less than what was requested. Judging from the results of the students' answers given on this indicator, most students have understood the direction questions.

**3.1.3. Purpose.** Based on Table 4, the average scores obtained by students purpose is 0.92 to 46% that can be answered correctly by students. Critical thinking skills in precision indicator into the category of low [7]. The expected answer is student describes the two purpose of the efforts made to preserve biodiversity. There are only 16 students who give the expected answer. The other students just give one objective of the efforts made to to conserve biodiversity or just call the effort without explanation. Judging from the results of the students' answers given on this indicator, most students have understood the direction questions.
3.1.4. **Concept.** Based on Table 4, the average scores obtained by students on the indicator concept was 1.49 with 50% that can be answered correctly by students. Critical thinking skills in the indicator concept into the category of low [7]. Answer expected that students expressed concern about the concept of coral reefs in Indonesia. Most of the students’ answers are in accordance with the expected but partly not quite right.

3.1.5. **Assumptions.** Based on Table 4, the average scores obtained by students in the indicators point of view is 1.49 to 75% that can be answered correctly by students. Critical thinking skills in assumptions into the category of high [7]. The expected answer is giving students the assumption of the efforts that have to conserve rhinos. Around 27 students have to be able to give assumption of the efforts that have to conserve Rhino Judging from the answers that students give to this indicator, the students have understood the direction questions because most of the students have been able to provide assumption according to the theory underlying the rhino conservation in situ.

3.1.6. **Points of view.** Based on Table 4, the average scores obtained by students in the indicators point of view are 1.54 to 51% that can be answered correctly by students. Critical thinking skills in the indicators point of view into the low category [7]. Answer expected that students give the right perspective as a researcher of on the efforts already made to preserve biodiversity by two reasons right. There is only one student answered as expected, while others respond with reasons that are less precise. Judging from the answers that students give to this indicator, the students do not understand the direction the questions asked yet.

3.1.7. **Interpretation and Inference.** Based on Table 4, the average scores obtained by students in the indicators point of view is 1.27 to 64% that can be answered correctly by students. Critical thinking skills in the interpretation and inference indicator into the category of being [7]. The expected answer is that students can draw the appropriate conclusions from the problems that led to the death of an elephant which impact on reducing the number of population in accordance with a given article. The answer given by students mostly already giving cause that resulted in the death of an elephant with complete. Judging from the answers that students give to this indicator, the students have understood the direction questions.

3.1.8. **Implication and Consequences.** Based on Table 4, the average scores obtained by students in the indicators point of view is 2.03 to 68% that can be answered correctly by students. Critical thinking skills in the indicator implication and consequences into the category of being [7]. Answer expected that students declare three consequences of the relationship between the problems of the current status of coral reefs with biodiversity of coral reefs in the days to come. A total of 10 students have been able to provide three consequences prompted, and mostly students provide two or even just one of the consequences of the relationship between the problems of the current status of coral reefs with biodiversity of coral reefs in the days to come.

3.2. **Critical thinking skills of students overall student**

The data obtained, analyzed per each indicator also then analyzed as overall student scores. Here is the data acquisition overall student results:

| Table 4. Data from the acquisition of students |
|-----------------------------------------------|
| \( \bar{x} \) | 56.76 |
| Score max   | 70   |
| Score min   | 40   |
| Sd           | 7.75 |
Based on Table 4, the average value of the acquisition of the student as a whole was 56.76. Maximum score obtained with 70 students, a minimum value of 40 and a standard deviation of 7.75. This means that more and more data varies from the average.

Table 5. Data critical thinking skills of students overall

| Interpretation (%) | Frequency | Percentage | Category   |
|--------------------|-----------|------------|------------|
| 81.25<X ≤ 100      | 0         | 0%         | Very high  |
| 71.5 <X ≤ 81.25    | 0         | 0%         | High       |
| 62.5 <X ≤ 71.5     | 10        | 27%        | Average    |
| 43.75 <X ≤ 62.5    | 27        | 73%        | Low        |
| 0 <X ≤ 43.75       | 0         | 0%         | Very Low   |
| Total              | 100%      |            |            |

Based on Table 5, critical thinking skills of students on social science issues of biodiversity subject are in the low category of 27 persons and the medium category of being 10. This data is derived from the number of acquisition results of each student in answering questions critical thinking which biodiversity have been classified based on the framework developed by [8]. Here is the percentage of students' critical thinking skills in social science issues of biodiversity subject.

![Pie chart](image)

Figure 2. Percentage of students' critical thinking skills

Critical thinking skills of students in materials science social issues of biodiversity based on the results of research it turns out there at low and medium categories. It can be influenced by aspects of learning by the teacher in the learning process. Students do not have the experience to think critically using social science issues developing in society.

Based on several studies, the integration of socio-scientific issue in learning can improve critical thinking skills, including research conducted by Tal & Kedmi (2006) [9,10]. According to[11], the use of SSI as a context for learning can train student’s critical thinking skills through three important aspects, namely (1) students need to understand and describe the problem situations involving SSI; (2) the students formulate a number of problem solving solutions that enable on the situation that to learned; and (3) students need to re-evaluate the decisions they have made before the decision is communicated within the forum. The process trains students to think more carefully and to be more reflective in making decisions. Students do not just use one source for consideration, but pay attention to other sources before the final decision is taken. Because SSI involves science and social issues, the students need to pay attention to the impact that would arise from the two sides [12].
3.3. Teacher Interviews

Besides using open-ended question about which is given to students to determine the skills of critical thinking in social issues in materials science biological diversity, conducted interviews to teachers who teach in the classroom where the data retrieval. Here is a short interview with teachers about instructional materials used in biodiversity

Table 6. The list of questions and interview teachers

| No. | Question                                                                 | Answer                                                                                      |
|-----|--------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 1   | How to teach biodiversity matter?                                        | Using contextual approach namely the observation of biological diversity in the school environment. |
| 2   | Why use this way?                                                        | Racing on core competencies and core competencies                                          |
| 3   | In the teaching material Does biodiversity using social science issues?   | Not                                                                                        |
| 4   | issue of what is used in teaching materials of biological diversity?     | Not                                                                                        |

Based on interview result to teachers who teach in the classroom where the data retrieval, we can draw that students do not have the experience to think critically and using socio-scientific issues on learning process. The teacher who teach in the classroom where the data retrieval using contextual approach to learning biodiversity because the school yard very board and there are various kind of plant. So, the students were asked to observation of biological diversity in the school environment. This research is the first time the student time acquainted with critical thinking and socio-scientific issues.

4. Conclusion

The critical thinking skills profile of students on each indicator is considered at very low for the question at issue, the moderate category for information, the low category for the purpose, the low category for the concept, high category for the assumptions, the low category for points of view, the medium category for interpretation and inference, as well as the moderate category for the implication and consequences. And for the critical thinking skills of students on social issues of biodiversity materials science students overall acquisition value entered in the category of low and medium. Therefore we need a learning activity that is able to develop students' critical thinking skills, especially regarding issues of social science.

5. References

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