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Gender differences in science learning: how is students' questioning quality through STEM based e-module?

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Abstract. Science learning in this century has highly demanding for students' outcome. Higher order thinking skills has become a main goal for science educator. Higher order thinking skills include critical thinking skills, creative thinking skills, argumentative skills, inquiry skills and others. Inquiry skills or questioning skills is highly important for students in science learning to construct that skills, students should have a curiosity. Learning strategy, method, and approach must be effective to promote it. One of them is STEM learning which is covered in technology such as electronic books. So, that this research using STEM based E-module to construct students questioning skills. However, there are differences of learning style, reading habit, and others between girls' and boys' students which effect their skill. Purposes of this research is to investigate how the question quality of girls' and boys' students using STEM based E-module in science learning. The method that is used pre-experimental with subject 26 students, 24 girls' students and 2 boys' students as freshman in second semester who take science courses in environmental theme. The technique to take the data in this research is used recording activity from Free Conference Call applications, reading test, and observation. The instruments such as transcript from WhatsApp application chatting group, Free Conference Call application recording activity, questionnaire, and "Pojok Inquiry" activity which is linked in STEM based E-module that consist of five reading material or narration for each sub-theme. Data analysed by using question quality category rubric. The results shown that there is difficulty to investigate significant differences of question quality between boys' and girls' students obviously. However, there are interesting results of the questions quality category results of girls' and boys' students. Boys has outperformed in understanding, relationship, and evaluation category than girls' students, while girls' students have outperformed in information, finding & solution than boys' students.

1. Introduction

Science learning in this century has highly demanding for students' outcome. The students' outcomes that is mean not only achievement in cognitive skills but also other skills that is include in higher order thinking skills. Higher order thinking skills has become a main goal for science educator [1 – 5]. Higher order thinking skills include critical thinking skills, creative thinking skills, argumentative skills, inquiry skills and others. Those skills can prepare them for next step in their career at workplaces or in their way of thinking, the way their decision making in life problems that is faced. In this era also demand the students not to immediately receive the information, but also, they have to ensure the validity and make them rigorous to read and receive the information. The first thing that students must have the skills is questioning skills that sometimes related to inquiry skills. Inquiry skills trigger the cognitive activity



that can be classified as higher order thinking [6]. Inquiry skills that begin with question has taken an important role in science learning. Questioning skills is really important during learning process especially science learning. Because the heart of science learning is curiosity that implemented by asking questions to do the scientific method. Posing questions is a key in the learning process and by questioning students helped direct their learning immersed with their prior knowledge and new information to make sense of the ideas. Students' questions also play an important role in meaningful learning and motivation, and can reveal about the quality of students' thinking and conceptual understanding [7]. Students' generated question is also a meta-cognitive that emphasize in cognitive process, for instance planning, predicting, monitoring, evaluating, revising, and creative act that is formed in a good question which has benefit for students to make sense what has been taught and construct the data and information during the lessons [8 – 10].

Nevertheless, students are shame to asking some question to the teacher during the lesson or after the lesson. This also similar with preliminary investigation with the questionnaire to the university students that is shown the data 48,2% said they are shy to posing their question in front of the people because they are not confident and afraid of their fault. The other result from [11] also shown the similar data that many students have stopped asking questions and they do not express a desire to discover, debate, or challenge. There are many factors that causes those phenomena. For instance, students view science as boring and difficult lesson, so they lack of interest in science [12]. The other one is about gender differences that causes questioning quality of the students vary each other. [13]. There was a significant gender difference in generated question. Only one of the five question types: girls group members asked significantly more probing questions than did their boys asked [14].

Those cases made students learning are obstructed because all those skills that they needed do not optimal. Pertaining of that, there should be an approached or method that trigger the students to asking the questions more, learning that interest them and construct their cognitive, creativity, also curiosity. One of the approaches that can develop their skills is integrating science, technology, engineering, and mathematics or it can be called STEM. STEM learning brings the concepts together through all four disciplines. The concepts are scientific inquiry immersed the formulation of a question that can be proven through investigation, engineering design immersed the formulation of a problem that can be solved through constructing and evaluating during the post design stage [15]. By the STEM learning approach, science lessons usually run by the laboratory activity that construct student's inquiry. In the laboratory activity, students are habituated to the scientific inquiry method and promote inquiry skills. Inquiry refers to varied ways in which scientists study the natural world, propose ideas, and explain and justify the fact from investigation [16].

Thus, this learning needs some guidance for each theme in science learning. Teaching materials like module are needed to cover all those students needed in science learning without override hands-on activity as direct experiences. Following this digital era, text module can be substitute with electronical module which is easy to carry out, read everywhere, and the millennials students have interest on it. So that, electronical module (E-Module) are suitable in this digital era for learning and trigger students reading interest include girls' and boys' students. Girls' students tend more conversation and communication value, then boys' students tend more technical and computational that can cover by the digital module with integrated hands-on activity. Thus, this research use STEM based E-module in science learning to investigate how students questioning quality based on gender differences that others have never examined it.

2. Methods

This research is using qualitative descriptive method with the subject 26 students, 24 girls' students and 2 boys' students as freshman in second semester who take science courses in environmental theme. This learning uses STEM based E-module that involve sub theme soil pollution as activity 1, water pollution as activity 2, and air pollution as activity 3, which is integrating all four-disciplines of science covered by STEM. Those students are divided into four groups during the learning. They are asked to read and do the experimental activity. Each sub-theme has their own activity that all groups should do that and

report it in the next meeting after they have done the experiment. All the activity done by students at their home and presentation done by online learning using Free Conference Call application and WhatsApp application for supervise their activity. After doing each experiment activity they have to done fill all the reports and done “*Pojok Inquiry*” activity which is linked in STEM based E-module.

The technique to take the data in this research is used recording activity from Free Conference Call applications, reading test, and observation. The data that all students’ questions taken in this research with some instruments such as transcript from WhatsApp application chatting group, Free Conference Call application recording activity, questionnaire, and “*Pojok Inquiry*” activity which is linked in STEM based E-module that consist of five reading material or narration for each sub-theme. The form of this type activity is narration from news related to each sub-them, then students has to posed their own questions as they wanted to know from those narrations.

Those questions are analysed by the question quality category rubric according to [17] as shown briefly in table 1:

Table 1. Question Quality Category

Question Quality	Category	Description	Question Type
<i>Closed Question (Low Level)</i>	Information	Questioning about information or fact Direct and simple answer with only ‘yes or no’ answer.	What...? Where...? Which...?
	Understanding	Question that need explanation which help students get their concept, fact, phenomena, task, and procedure. There is no direct and simple answer.	Why...? How...?
<i>Open Question (High Level)</i>	Relationship	The purposes of question are to comprehended the causes and consequences. Question has relationship with two or more concepts.	Which consequences...? Which differences...? What happen...?
	Evaluation	Students try to find the guide to make a decision or express their personal opinion. This question shows students’ point of view, their choices, and judgement for a problem.	Which is the best...? What is opinion...? What do we think about...?
	Finding and Solution	The question purposes are to comprehended a complex problem. The answer is related with identification or solution from a problem.	What if...? if...then....

3. Result and Discussion

The results of students’ questioning quality during science learning using STEM based E-module are taken from the three sub-themes, such as soil pollution as activity 1, water pollution as activity 2, and air pollution as activity 3. All the questions are collected and analysed with question quality category rubric between girls’ and boys’ students. Those questions come from students asking question during the presentation, the experimental activity, and they asking question based on the narration that has been read in the reading text that is linked in STEM based E-module. Those questions quality category is categorized as closed question (information, understanding) and open question (relationship, evaluation, finding and solution). Each category is calculated as percentages between girls’ and boys’ students. The results are described as diagram that is shown in Figure 1.

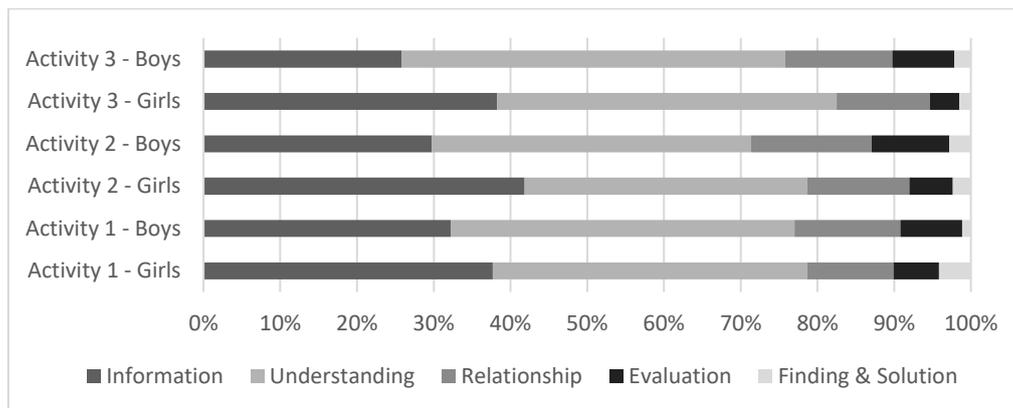


Figure 1. The Results of Question Quality Category between Girls' and Boys' Students

From data above, there are percentages for each question quality category between girls' and boys' students in every activity. Most of them has an improvement of question quality from activity 1 to activity 2. Based on the data informal interview with students and spread the questionnaire, they are really interest with this lesson using STEM based E-module and really like those experimental activity on it. Students will show their interest and an improvement in learning or their skills, for instance inquiry or questioning skills when they do something which they like and something new, such as experimental activity based on STEM learning and electronic module [18, 15]. According to [19] shown that teenager can be called as a group that is also known as digital natives, who tend to have different expectations and behaviours toward the use of digital media, in the fact that they born with technology. The use of electronic books (e-books) such as E-module for reading and activity are needed, especially in the context of a science learning, in which younger students seem to prefer reading e-books for improve some skills that is important for them in everyday life [20, 21].

However, they do the last activity, activity 3, air pollution activity, they have decreased the question quality. It is caused the difficulty of material itself. Also, all students, either girls' or boys' students feel difficult to understand and lack of interest of that lesson. This is also unique results that students feel boring to fill the reading test in "*Pojok Inquiry*". They said it is too much narration that they have to read. Especially, boys' students fill the reading test in the deadline. According to [22] students will only engage in asking question if they are interested in the topics studied especially in science and the classroom environment inhibits. It obviously the students, especially university students as a subject has lack of their interest in reading, become lack of literacy, also promote lack of curiosity, and the impact is decreasing the quality of students' questions. Reading skill, reading interest could be affected to understanding of text, fact in text, also others cognitive activity [23, 24]. Boys' students have insufficient interest in reading, which compared to the past has considerably decreased, is very frequent, they tend to read less and less [24]. The results show that while the girls' student mostly had the behaviour of Skimming during the reading process than boys' students [25]

The data also shown that there are several differences of question quality between girls' and boys' students in different quality category at every activity. Boys has outperformed in understanding, relationship, and evaluation category than girls' students. From this result, it can be described that boys' students more rational than girls' students in thinking. Boys' students posing a question in the time that they really need to answer when they are triggered in experimental activity. They tend to assemble the tools and make a procedure, then they see their friends works and evaluate them if they do something wrong. Evaluation questions category could be related to the fact that this kind of questions demands a high reasoning ability [17]. Boys tend to use their reasoning than the girls, so that boys' questions quality more included in Evaluation. Boys' questions also are indicating to procedural question when they faced experimental activity which is included in understanding category. Thus, they relate both becoming relationship question quality category. While girls' students have outperformed in information, finding & solution than boys' students. Girls' students need basic information before experimental activity.

Girls' students were facing a new topic, in this case the topic is related to Environmental practice topic [26], and they were trying to find answers to their doubts [17], so that they outperformed in finding and solution category. The example of quality questions category between girls' and boys' students can be described in Table 2.

Table 2. The example of quality questions category between girls' and boys' students

<i>Question Quality</i>	<i>Category</i>	Boys' Students	Girls' Students
Closed Question (Low Level)	Information	What is the factor from chemical pollution?	What is the meaning of Soil Washing?
	Understanding	Why Al (aluminium) has dangerous chemical residue?	How the local government policy for air pollution happened?
Open Question (High Level)	Relationship	What will happen to human health when breath the chemical residue?	What differences when rider breath the residue of smoke from vehicle with and without mask?
	Evaluation	The technology is created for make human activity easier, but they have side effect in human health or environment. What do you thing about to any technology that has no side effect?	What do you think that people still littering to the river, whereas there are a lot of trash can in front of their house?
	Finding and Solution	What if pesticide is continuing to use then natural pest killer also used, How the growth of plant and the quality of fruits? So, the plants do not harmful for human being.	The data needs to be retaken. What if we change the animal subject from grasshopper to butterfly, how is the procedure? And how are the results?

This is interesting result that there is no better and worse in question quality between girls' and boys' students. They have their own excellence and deficiency. Thus, it is difficult to investigate significant differences of question quality between boys' and girls' students obviously. Despite from the observation when the discussion is ongoing in experimental activity, girls talk too much and more posing the questions than boys done. While boys' students tend to practical and direct to arrange the experimental activity with less talking. Quantity of the questions is not describing the quality itself. At least, the students either girls' or boys' student's quality questions are included in all category. There is a question in open questions category, it means that learning method, strategy, and approach can develop their questions quality and also triggering their bravery to pose the questions. All of the questioning skills development needs a process, habit, and practice in learning process, especially in science learning between teacher and students.

4. Conclusion

This result can be concluded that there is difficulty to investigate significant differences of question quality between boys' and girls' students obviously. However, there are interesting results of the questions quality category results of girls' and boys' students. Boys has outperformed in understanding, relationship, and evaluation category than girls' students, while girls' students have outperformed in information, finding & solution than boys' students. Overall results shown that the students either girls' or boys' student's quality questions are included in all category. There is a question in open questions category, it means that learning method, strategy, and approach, experimental activity in using STEM based E-module can develop their questions quality and also triggering their bravery to pose the questions.

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