Critical thinking skills profile of senior high school students in Biology learning

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Abstract. Critical thinking is an important and necessary skill to confront the challenges of the 21st century. Critical thinking skills accommodate activities that can improve high-order thinking skills. This study aims to determine senior high school students' critical thinking skills in Biology learning. This research is descriptive research using instruments developed based on the core aspects of critical thinking skills according to Facione which include interpretation, analysis, evaluation, explanation, conclusion, and self-regulation. The subjects in this study were 297 students in grade 12 of a senior high school in Surakarta selected through purposive sampling technique. The results of this study showed that the students' critical thinking skills on evaluation and self-regulation are in good criterion with 78% and 66% acquisition while 52% interpretation, 56% analysis, 52% conclusion and 42% explanation indicate sufficient criteria. The conclusion from this research is that critical thinking skill of the students still was in enough category, so that needed a way to enhance it on some indicators.

1. Introduction
The 21st century is a century of rapid development of science and technology. 21st century advancements occur in various areas of the life sector and demand humans work with complex thinking and communication skills [1-3]. Critical thinking skills are important and necessary skills to face the challenges of the 21st century. Critical thinking skills accommodate activities that can improve high-order thinking skills (HOTs). Critical thinking skills are one of the skills needed to address the demands of the 21st century to deal effectively with social, scientific and practical issues in the future [4,5]. Critical thinking skills are the skills and the inclinations to make and conduct assessments of evidence-based conclusions [6]. Students who have critical thinking skills will strive to provide logical reasoning in understanding and making complex choices, as well as understanding the interconnections among systems. In addition, students may also have the ability to compose, disclose, analyze, and resolve problems [7]. Therefore, these skills need to be familiarized to be trained in school learning so that it becomes a skill that becomes the provision of the students to face the future and demands of the 21st century.

Critical thinking skill is necessary for biology learning in schools. Curriculum development, especially in biology learning, is also inseparable from the future trends in biological sciences such as biomimetics, nanobiotechnology, directional genomics, neuro tools, nano energy, and quantum encryption. This is because the technology based on biological processes becomes one of the characteristics of the 21st century to solve the increasingly complicated and complex life problems that require an effective and efficient solution. One solution is through critical thinking skills [8]. However, the skills of critical thinking in students according to some research results in the world are still in the low category. The low level of thinking skills of Indonesian students can also be seen from the results of the study of The Program for International Student Assessment (PISA). The results of a once-a-year study using instruments to test science literacy closely related to high-order thinking skills.
show that Indonesia ranked 60th out of 65 participating countries in 2009, 64th of 65 participating countries by 2012, and 69th rank of 75 participating countries by 2015 [9-11]. These results indicate that Indonesian students have not yet been trained to think high levels, causing the results of each PISA-held test still put Indonesia at the bottom and still below the average score standard of the Organization for Economic, Cooperation, and Development (OECD). Based on this background, this study aims to determine students' critical thinking skills in Biology learning in senior high school.

2. Research method
This research is a descriptive research using instruments developed based on the core aspects of critical thinking skills according to Facione which include interpretation, analysis, evaluation, explanation, conclusion, and self-regulation [12]. The subjects in this study were 297 students in grade 12 of a high school in Surakarta selected through purposive sampling technique. The data were obtained from the analysis of student answers. The data were obtained by coding each student's answer and scoring each student's answer based on the assessment rubric. Scores obtained by students were then converted in percentage form.

3. Result and discussion
The result of the students critical thinking skill test as shown in Figure 1 shows that there are only two aspects that get good criterion that is on aspect of evaluation with acquisition equal to 78% and self-regulation equal to 66% while the four other aspects are still in enough criterion that is the interpretation equal to 52%, 56% analysis, 52% conclusion, and 42% explanation.

![Figure 1. The Percentage of the Students' Critical Thinking Skills Aspects](image)

The critical thinking skill test resulted in the evaluation aspect score that reached 78%, the highest score. This suggests that the students have more competent skills in judging the credibility of someone's statement and representation and have a logical value of statements, descriptions, and questions [13]. To evaluate means to assess a statement or other representation credibility of perception, experience, situation, judgment, belief, or opinion, judging the actuality and clarity of an opinion, description, question or forms of representation. Evaluation is done by examining the source of information to assess its quality as a basis for decision-making based on identified criteria [14].

The critical thinking skill aspects of the students which enter other good categories equal to 66% are self-regulation. It is a self-consciousness to watch over the cognitive activities, the elements employed in activities primarily in applying skills to question, confirm, validate, or correct either one's reasoning or one's outcome. The sub-skills of self-regulatory are self-examination and self-correction.
It was found that the students have been able to deliver their opinions or judgments to regulate themselves through the problems presented. This self-regulation becomes a key aspect to master because it is an ability to watch over one’s cognitive activities and to make sure that oneself is involved in thinking critically or not [12]. Self-regulation can also be functioned in self-direction to help the students [15,16].

The student's critical thinking skill in the aspect of analysis shows enough criterion that is equal to 56%. Analysis means identifying, analyzing a relationship concerning questions, concepts, descriptions or other activities used in expressing beliefs, judgments, experiences, reasons, information or opinions [12]. The test results showed that aspects of analysis need to be trained more to the students so that they are accustomed to analyzing a thing to enhance the critical thinking skills had by them.

The aspect of interpretation and conclusions from the study results indicate that the same score; that is 52%. The training of this aspect also needs to be improved because interpreting and concluding are the important skills in realizing someone who can have good critical thinking skills. Students who have good interpretation skills will easily understand and put forward the meaning of various experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria. There are three sub-skills of interpretation covering categorization, meaning solving and meaning clarification. Categorization is used to capture and to formulate categories, differences, frameworks, and to describe information so as to understand its meaning, such as sorting and subclassifying information, reporting on what is experienced, and classifying findings or opinion data. The coding identification is used to detect, present, and explain the information content presented in a communication-based convention. Clarifying meaning is used to create explanations through determination, description, analogous meanings of certain words, ideas, concepts, numbers, images, symbols, charts, graphs or events [12]. Meanwhile, the conclusion aspect is also important to master because it identifies every argument needed to draw a reasonable conclusion, to form allegations and hypotheses, and to consider relevant information. It has three principles among which is to make generalizations and to use language that describes generalizations including definite references in making decisions [17]. The students are considered more competent in making conclusions or hypotheses in accordance to the facts, judgments, beliefs, principles, concepts, and representations when they have the ability to conclude [13].

The test results showed that the aspect that has the lowest score is the explanatory aspect of 42%. The explanation is the ability to present in a convincing and coherent way a person's penalty results. The sub-skills in explanation are to explain methods and outcomes, to justify procedures, to propose and defend with good reason and explanation of concepts of events or points of view, representations that use arguments correctly [12]. The answers presented by students indicate that the students have not been able to give a good explanation because the students just convey the explanation in the form of description. In fact, the explanation should not only be a description or a phenomenon but include an explanation of the causal or process relationship, the reinforcing argument, which links logical descriptions and relationships and uses the memorial data as the basis of explanation [18].

In general, the average of all aspects of critical thinking skills indicates a sufficient category with a mean of 57.6%. This is because the students are not accustomed to facing questions that require them to think critically or think high level. This is relevant to the results of the three-year PISA study from 2009 to 2015 for Indonesia showing low results because students are less accustomed to higher-order thinking. In addition, the results shown from the test results are also caused by several other factors such as the learning process that takes place in the class that is not accustomed to training critical thinking skills according to the demands of the 21st century. Though 21st century learning should be familiarized to use a learning model that encourages students to search from various sources of observation, not just being told. Learning is also directed to familiarize students in formulating problems, not just solving problems and practicing critical thinking instead of mechanistic thinking. Cooperation and collaboration are also emphasized in solving problems in the learning process [19,20]. Learning should also transform learning accustomed to low-level thinking skills into learning that emphasizes high-order thinking skills as well as trains literacy skills [21-23]. Therefore, critical thinking skills need to be trained to students early in the learning process at schools and become a
priority learning objective [24]. This is also in line with the formulation of the 16 principles of learning according to the Indonesian National Education Standards Agency (BSNP) that must be met in the 21st century education process, among which is to change factual thinking towards the critical, and from the delivery of knowledge to the exchange of knowledge [25].

4. Conclusion
The results showed that the profiles of the students' critical thinking skills gave different results on each indicator and were still in fairly average categories. Therefore, needed a way to enhance critical thinking skills on some indicators.

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