Profile of pre-service physics teachers’ critical thinking skills related to heat transfer

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Abstract. One of the skills needed to meet the challenges of 21st century is critical thinking skills. This study aims at describing the profile of pre-service physics teachers’ critical thinking skills related to heat transfer. This research is a descriptive research conducted in the physics education program at one of the private universities in Jakarta. Data collection is done through the test of critical thinking skills related to heat transfer. The collected data is analysed quantitatively. The results showed that 0% of students were in the category of high critical thinking skills, 25% on moderate critical thinking skills, and 75% on low critical thinking skills. Thus, the critical thinking skills of pre-service physics teachers still belong to low category.

1. Introduction
Higher education is a process in which students prepare to be able to survive to live their lives later. Given, in the 21st century more and more challenges will be faced both external and internal challenges. Therefore, it is considered crucial to prepare the students to face those external and internal challenges. The external challenges that might be appeared are in the form of globalization era with the enactment of the ASEAN Economic Community, environmental issues, advances in information technology, convergence of science and technology, knowledge-based economy, the rise of the creative and cultural industries, shifting of world economic power, influence and impact of techno-science, quality of investment and transformation in the education sector. Those external challenges require the college graduates to possess good communication skill, critical thinking, and problem solving ability. They are also demanded to become responsible citizens, to try to be tolerant and to be able to accept different views from the others so they are ready to survive in a globalized society. All of those qualities can be achieved if the students are prepared to develop their intelligence, talent, interest, and their working readiness. Beside the external challenges, the students also face challenges coming from internal side such as rapid population growth, depletion of natural resources, the energy crisis and many more.

Higher education should be able to produce human resources that are able to compete in the 21st century, namely resources that master a variety of skills needed to face the challenges of the 21st
century. One of the very important skills to be trained and developed for students in facing 21st century competition is critical thinking skills [1].

Critical thinking is one of thinking skills that uses complex thinking processes [2]. Critical thinking is a mental activity that requires cognitive skills in solving problems, making decisions and drawing conclusions [3]. Critical thinking is a reasoned decision-making process based on consideration of available evidence, contextual aspects of the situation, and the concepts in question. Critical thinking as thinking that facilitates decisions because it is based on real criteria, which are self-corrective and substantive in context. Someone can be said to think critically, when someone has been able to make research or make reasonable decisions about a quality of what he has seen, and has thought. Critical thinking skills are an ability that everyone has to pursue relevant and trustworthy knowledge by involving the evaluation of evidence. The ability to think critically is a complex thinking skill that is needed in decision making to analyse a problem to the stage of finding a solution to solve the problem. Critical thinking is a thought process that is involved in decision making. The combination of decision making and problem solving with critical thinking leads to great ideas and solutions [4]. Critical thinking is all mental activities that help in making decisions [5].

Critical thinking is the thought process involved in decision making [6]. Critical thinking is efficient in the decision making process [7]. In developing and evaluating solution strategies, students need to engage in critical thinking to be able to identify solutions, to combine multiple perspectives and to monitor and manage their own problem solving processes, especially during group work [8].

One of the learning objectives of the Physics Education program at the sample university stated that Physics Education program graduates are required to be able to apply critical thinking skill. This skill involves high-order thinking skill inside it. The critical thinking skill becomes an essential part of thinking construction theory. The learning to think is important because thinking is necessary to develop attitudes and perceptions that support the creation of positive class conditions, to acquire and integrate knowledge, to broaden knowledge horizons, to actualize the meaningfulness of knowledge, and to develop a favourable thinking behaviour [9]. In addition, critical thinking skill can be utilized by their students when they live around the community. Thus, this skill is very important to be trained and developed in the learning process in higher education. This study aims at describing the profile of pre-service physics teachers ‘critical thinking skills related to heat transfer.

2. Methods

This research is a descriptive research conducted at Physics Education Study Program in one of the private universities in Jakarta. The research subject was the 1st semester students consisting of 38 students. The instrument used was the test of critical thinking in the form of essay related to heat transfer can be seen in Figure 1. Data collection was done through critical thinking skills test and the data collected were analysed quantitatively and were then described. Indicators of critical thinking skills measured are reasoning, hypothesis testing, argument analysis, and likelihood and uncertainty analysis [10].
1. What happens to the ice cubes inside a glass bottle filled with water if the centre of the bottle is heated like in the picture:

In your opinion, will the ice melt or not melt? Give an explanation!

2. Adam stated that when heating water in a container a convection process occurs in the water. If the water is continuously heated, the temperature also continues to increase until the water boils. Thus, the rate of heat convection flow when the water boils becomes faster. Adam's statement above contains errors. In your opinion, where is the error in Adam's statement? Give an explanation!

3. Nike who wants to open a dumpling business to the store to buy a pan. Nike wants a pan that can warm dumplings at 4000 J/s - 4500 J/s. If the temperature of the electric stove used is 40 °C and the temperature of the Nike room is 29 °C. Pot sellers offer pans with a diameter of 20 cm and thickness of 2 cm. What additional information does Nike need to know before making a decision about purchasing a pot offered by the seller? Give an explanation!

**Figure 1.** Example of critical thinking instrument test.

3. **Result and discussion**
   The result of data analysis in Table 1 shows that students' critical thinking skill is still in low category.

   | Category of Critical Thinking Skill | % Number of Students |
   |------------------------------------|----------------------|
   | Low                                | 75%                  |
   | Moderate                           | 25%                  |
   | High                               | 0%                   |

   The low level of students' critical thinking skills is caused by students not being trained in critical thinking in learning. The learning given by the lecturer does not contain stages that involve students to think critically. Though critical thinking can be trained through learning that contains stages that involve critical thinking students are trained. Stages that contain critical thinking for example learning that contains stages that present a challenging problem or a problem that requires decision-making skills. Some critical thinking roles in decision making [8]: (1) helps in identifying the problem at hand; (2) helps in gathering relevant information; (3) helps in analysing alternative problem solving to determine the best choice; (4) helps in evaluating decisions that have been taken.

4. **Conclusion**
   Pre-service physics teachers’ critical thinking skills related to heat transfer are mostly categorized as low, some students perform moderate skill level, and no student has high skills. Thus, it is
recommended to the next researcher to develop a learning program that can train the pre-service physics teachers’ critical thinking skills.

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