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An Analysis Identification of Physics Student Critical Thinking and Creative Thinking Skill in Physics Learning

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Abstract: The quality education depends on quality of learning process. So, it was ooooneeded to know how the student initial ability. This research aimed to describe the physics students critical thinking skill and creative thinking skill about physics concept. The method was descriptive research. The research respondents were physics students of 37 person at Class A, it consists of 5 male students and of 32 female students and physics student of 35 person at Class B, it consists of 5 male students and of 30 female students which have been take thermodynamics and modern physics on odd semester, academic year 2018/2019. The research data which was collected by using test, observation and documentation. The research data was analysed by using indicator percentage and descriptive. The result showed that average of critical thinking skill was 78,65. Interpretating around 6,8 Analysing around 8,17, evaluating around 8,97, Inferensi around 8,41 and explanation ability around 6,94. The average of creative thinking skill was 78,92. Creative thinking skill was fluency was 8,09, flexibility 8,4, origionality 7,58 and elaboration 7,45. Therefore, an effort needed to improve physics student critical and creative thinking skill. It can be done by using some interactive model, media and teaching material in physics learning. Beside that needed alternative solution for development learning resource on learning physics in Higher Education with another local potential context.

Keywords: ***Critical Thinking Skill, Creative Thinking Skill, Physics Learning***

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Introduction

The existence of internal and external challenges underpins the refinement of the 2013 curriculum, as mandated in the Minister of Education and Culture Regulation No. 59 of 2014. External challenges are associated with globalization, environmental issues, scientific and technological advancements, the emergence of creative industries, cultural developments, and international education trends. In revising the curriculum, a key focus is on standardizing processes and assessments to foster high-level thinking skills, including critical and creative thinking. In education, the learning process plays an important role in knowing the potential that exists in each student. Learning does not only provide knowledge, but students are also required to be active so that they can develop the potential that exists in themselves (Putri et al, 2021).

Thinking skills are skills in managing the mind or cognitive system consisting of knowledge, observation, and production. In addition, thinking skills also mean the ability to make decisions to solve problems based on information and experience (Nuraini et al, 2022). High-level thinking skills are thinking skills that are not just recall, but restate, or refer without processing (recite). High-level thinking skills include several abilities, namely: 1) transfer one concept to another, 2) process and apply information, 3) find links from different information, 4) use information to solve problems, and 5) critically examine ideas and information (Widana, 2017). In terms of the knowledge dimension, high-level thinking skills are not just knowledge in the factual, conceptual, or procedural dimensions but reach the metacognitive dimension (Anderson & Krathwohl, 2001). The metacognitive dimension describes the ability of learners to connect several different concepts, interpret, problem solving, discovery, reasoning, and making the right decisions.

Currently, learning that is oriented towards achieving critical and creative thinking skills is the focus of education because it provides many benefits for students (Djupanda, et.al., 2014). Widana (2017) states that learning and assessment involving higher order thinking skills can provide several benefits for students, namely 1) preparing students' competencies for the 21st century, 2) fostering a sense of love and care for regional progress because the assessment of higher order thinking skills is generally context-based which is close to the student's environment and requires sufficient mastery of concepts, 3) increasing students' learning motivation, and 4) improving the quality of assessment. Good learners not only have high conceptual mastery but also have good retention of their knowledge (Jensen, et.al., 2014). Critical and creative thinking skills enable learners to overcome challenges in today's information age, where there is too much information but very limited time to process it (Liliawati, 2011). Learners who have high-level thinking skills will be able to analyze a complex condition and be able to provide good ideas and arguments so that they are ready to enter modern society today (Facione, 2013).

Critical and creative thinking skills can be trained in the learning process in the classroom. Therefore, in order for students to have high-level thinking skills, the learning process also provides opportunities for students to find activity-based knowledge concepts. Activities in learning can encourage students to build creativity and critical thinking. Physics teachers can implement student center learning (SCL) to develop critical and creative thinking skills. A variety of ways can be applied to develop higher order thinking skills, including by implementing elaboration activities; learning strategies; learning strategies (Bonk and Smith, 1998), computer-based learning (Richardson and Ice, 2010), experimental activity in the laboratory; scientific approach by utilizing appropriate learning resources (Murphy et al., 2013); inquiry learning in the

laboratory and associated real world phenomena (Madhuri, et.al, 2012); application of collaborative groups and real-world experience (Vijayaratnam, 2012).

Physics learning is a process of learning to solve problems through observation and description of the human mind The learning process directed at achieving critical and creative thinking skills requires a variety of adequate support systems, including facilities, materials, and tools needed to carry out the learning process (Joyce et al., 2009). Madhuri et al. (2012) stated that adequate laboratory equipment can facilitate students in learning about HOTS. Some other supporting systems that can facilitate students to master critical and creative thinking skills are interactive multimedia (Khan & Masood, 2015); appropriate assessment tools (Anderson and Krathwohl, 2010; van den Berg, 2004), and learning modules (Zohar dan Dori, 2003).

Several research studies have been conducted to obtain an overview of students' higher order thinking skills. The results of the international study of the Program for International Student Assessment (PISA) show that the literacy of Indonesian students is categorized as low in: (1) understanding complex information; (2) theory, analysis, and problem solving; (3) use of tools, procedures and problem solving; and (4) conducting investigations (OECD, 2018). The results of several other studies also show that students' HOTS achievement is still unsatisfactory (van den Berg, 2004; Milner-Bolotin & Nashon, 2012). However, there is no study that examines and describes how the condition is for students in the Jember Regency area and for prospective physics teacher students. In addition, the profile of support systems that facilitate higher-order thinking learning owned by senior high schools (SMA) has not been widely identified through research.

The ability to think critically and creatively is an important skill that must be possessed by students and prospective teachers, on the other hand, a profile of mastery of high-level thinking and a profile of the support system is needed as a basis for designing a learning system that is oriented towards achieving critical and creative thinking skills, so it is necessary to conduct this research. The research will focus on analyzing the achievement of critical and creative thinking skills of physics education students at Jember University. It is conducted on students because prospective physics teacher students will play a role in teaching critical and creative thinking skills when they are already in the world of work in schools.

Physics is a scientific discipline that studies natural phenomena and explains how these phenomena occur. Physics does not only contain theories or formulas to memorize but physics also contains many concepts (Astutik & Nuraini, 2021). Physics is a branch of science that studies natural events and processes. Physics is not only learning facts but also learning how to think and work scientifically. Understanding physics requires logical thinking (Nuraini et al, 2022).

The proposed research is related to the research roadmap of Theoretical Physics Learning Research Group. Research within the scope of Keris Theoretical Physics Learning is directed at the design of physics learning systems on Thermodynamics and Modern Physics that are oriented towards achieving critical and creative thinking skills. The learning system design in question has several components, namely learning tools, learning media, textbooks, modules, Learner Worksheets (LKPD), physics experiment tools and materials, critical and

creative thinking skills assessment tools and several other components. In order for the design to be carried out in accordance with the characteristics of students and conditions in the field, it is necessary to know and analyze the profile of critical and creative thinking skills in both physics teacher candidates. In addition, it is also necessary to know the support system that can facilitate the learning process that is oriented towards the achievement of higher order thinking. In the context of instructional design research, this proposed research is a need analysis activity for further research to be carried out by Theoretical Physics Learning Research Group.

Method

This research was descriptive research that describes critical thinking skills and creative thinking skills in physics students. There are two packages of questions developed, namely critical thinking skills questions and creative thinking skills questions (Arikunto, 2010). In addition, a questionnaire of teacher response to the carrying capacity of physics learning in college was also developed. The question package was tested on physics education study program students who have taken thermodynamics courses and/or are currently taking modern physics courses. Data collection techniques used critical thinking skills tests and creative thinking skills tests. Critical and creative thinking skills analysis techniques were carried out using percentages and analyzed descriptively.

Results and Discussion

The critical thinking skills test questions were 10 questions. Critical thinking skills indicators consist of interpretation, analysis, evaluation, inference, and explanation. The critical thinking skills indicator consists of 10 questions. Critical and creative thinking skills questions have been validated before use and show an average validation score of 89% stating that the questions are suitable for testing.

The results of the recapitulation of critical and creative thinking skills in students can be seen more clearly in Table 1 below.

Table 1. Grade Recapitulation

Average Recapitulation of Critical and Creative Thinking Skills	
Ability	Average score
Critical thinking skills	78,65
Creative thinking skills	78,92

Based on the results of the critical thinking skills text that has been tested on 35 undergraduate students of Physics Education, University of Jember, the value of each indicator is known as follows: analysis indicator with an average of 8.17, this shows the level of critical thinking on the analysis indicator is very good. Furthermore, the interpretation indicator with an average of 6.82 based on this it can be concluded that students' interpretation skills are still lacking. The inference indicator with an average of 8.41 shows that students' mastery in drawing conclusions from questions is very good. The evaluation indicator with an average of 8.97 shows that students' mastery in assessing statements from the question is very good. Explanation indicators with an average of 6.94, this shows that the ability of students to explain the reasoning of the knowledge gained to the problems that have been given is still insufficient.

This is in line with the research of Pradana et. al (2016), that the critical thinking skills of first-year students are still underdeveloped in temperature and heat material. The value of critical thinking skills of physics students is only 24.29 on a scale of 100 with the highest score of 76 and the lowest score of 4. According to Herayanti and Habibi (2015), the problem-based learning model has a positive influence in efforts to improve students' critical thinking skills. Meanwhile, Anita and Trisnawati (2016), in their research entitled Implementation of Elearning in Environmental Physics Courses to Improve Critical Thinking Skills and Student Learning Independence concluded that students' critical thinking skills were low with an average score of 51.00. A total of 11 students has low critical thinking skills out of 18 students. Student learning independence is classified as good with a percentage of the number of positive answers 72.78% and negative answers 27.22%.

Based on the results of the creative thinking skills test, the value of each indicator is known, namely: on the flexibility indicator with an average of 8.48, this error tends to be low because almost all students can answer questions number 5, 6 and 7 which are included in the description questions on the theme of radioactive radiation. These description questions make students better understand the intentions desired by the question. Question numbers 5, 6 and 7 are included in the questions with few mistakes because students in this question better understand the concept of radioactive radiation, can classify different categories and can provide various interpretations of answers in the form of complete descriptions. Fluent indicators with an average of 8.09, errors in this fluent indicator also tend to be low because students better understand the concepts of atomic models and isobaric processes so that students are fluent in describing answer ideas, and interpreting objects in the form of graphs in the problem. Original indicators with an average of 7.58, errors in original indicators are due to students already understanding the concepts already in the problem but lacking originality in answering questions number 3 and 4. Elaborative indicators with an average of 7.45, errors in elaborative indicators are caused by students in answering questions number 9 and 10, tend to ignore unit constants during calculations so that the calculation results obtained do not match the units asked in the question. Students are less precise in converting units and operating mathematically in accordance with the question. Students are also less careful in reading the directions of the available problems. Students in answering questions are less creative and less detailed in providing multirepresentation answers (pictures, graphs and others) in developing answer descriptions.

Creative thinking skills can produce new methods or ways to solve problems (Restanto dan mampouw, 2018). Students tend to be less careful in solving problems, resulting in low student creative thinking skills in several indicators, but there are several indicators that have a low error rate. Low and high scores on several indicators indicate the level of students' creative thinking skills. According to Anugrahaini et.al (2017), students' critical thinking skills are influenced by their knowledge and students' creative thinking skills are influenced by not being confident in new things. The higher the student's knowledge, the higher the level of critical thinking skills. Students who tend to be afraid to be different can affect their creative thinking skills. They are afraid of new answers so they think that the answer is wrong. This is what causes students' creative thinking skills to be low. Therefore, it is important to improve students' creative thinking skills by training them to solve physics problems.

Based on the results of research from Uloli et.al (2016), students' creative thinking skills are not only obtained from the description of learning outcomes, but can also be obtained from other perspectives. Lecturers need to know the level of student skills, making it easier for lecturers to see what level of student skills in solving problems, especially physics problems.Based on Anugrahaini's research (2017), the level of critical and creative thinking skills of students can be honed from the preparation of practicum reports. In this study, the level of critical and creative thinking skills of students accumulated was still classified as moderate. The cause of the level of critical thinking skills and creative thinking is still classified as moderate, namely the lack of facilities to carry out practicum, especially in thermodynamics and modern physics courses.

In the indicators of critical thinking skills, especially the indicators of interpretation and explanation, students are still relatively low. This can be improved by giving students practicum assignments, so that students can understand and reason their thinking skills through direct practicum. On creative thinking indicators, especially on original indicators and elaborative indicators, most students answer incorrectly. Students are less careful and tend to be almost the same answer. Original and elaborative indicators can also be honed by doing practicum. One of them improves by doing practicum reports that can be applied to objectives, theoretical basis, discussion, and conclusions. Therefore, supporting or carrying capacity such as the existence of a thermodynamics laboratory and modern physics is very important to improve critical and creative thinking skills. This is also supported by a statement from Bailin (2002) that much of the educational literature refers to understanding and critical thinking skills with certain processes or procedurally can be improved through practicum.

In improving students' critical thinking skills, it is not only with practicum. The results of research from Hager et.al (2003) state that students' critical thinking skills can be improved by giving problems in groups. This group problem solving project can emphasize students' critical thinking in many ways, one of which is group work. Therefore, students can be given group problem solving projects to improve critical thinking skills.

The results of research from Hunaidah (2018) also state that the critical thinking skills of physics education students can be improved by using a learning model. The learning model in question is the CinQASE learning model. The CinQASE learning model is specifically designed to be used to improve students' critical thinking skills with a 5-phase syntax, namely: 1) problem presentation, 2) individual work, 3) team work in collaboration, 4) class discussion, and 5) evaluation and feedback. In addition to the CinQASE learning model, there are also learning models that can improve students' critical thinking skills, such as the results of research from Pratama et.al (2016) which states that by applying a project-based learning model can improve students' critical thinking skills. Through the project-based learning model, students gain new experiences and knowledge. Indirectly, this provides a stimulus for students to think scientifically such as making a project.

To improve students' creative thinking skills also requires media and learning models. The results of research from Ramankulov (2016) state that the use of computer media as a means of learning physics can improve the creative thinking skills of prospective physics teachers. In addition, using computer models and complex laboratory virtual practicum can improve students' knowledge and creative thinking skills.

The results of this study indicate that the critical and creative thinking skills of physics education students at Jember University on the subject of thermodynamics and modern physics are still classified as moderate. This is due to the lack of carrying capacity. Therefore, it is necessary to have a carrying capacity such as a laboratory of thermodynamics and modern physics. In addition, it is also necessary to have a suitable learning model to improve the critical and creative thinking skills of physics education students at the University of Jember. The results of this study indicate that the critical and creative thinking skills of physics education students at Jember University on the subject of thermodynamics and modern physics are still classified as moderate. This is due to the lack of carrying capacity. Therefore, it is necessary to have a carrying capacity such as a laboratory of thermodynamics and modern physics. In addition, it is also necessary to have a suitable learning model to improve the critical and creative thinking skills of physics education students at the University of Jember.

Conclusion

Based on the results of the discussion, it can be concluded that from the results of the test questions it can be seen that students' critical and creative thinking skills still need to be improved. It is necessary to develop models, media and interactive learning to support students' critical thinking skills and creative thinking skills.

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