Jurnal Ilmiah Profesi Pendidikan
Volume 7, Nomor 4b, Desember 2022
ISSN (Print): 2502-7069; ISSN (*Online*): 2620-8326

The Analysis of Concept Mastering and Creative Thinking Skills of Prospective Physics Teachers Post-Online Learning During the Covid-19 Pandemic

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Article History
Received : October 12th, 2022
Revised : November 20th, 2022
Accepted : December 01th, 2022

Abstract: The current era of globalization and technology confronts humans with new challenges and increasingly complex problems. Mastery of concepts and creative thinking skills are two of several competencies that must be possessed by almost all professions at this time. This study aims to determine the extent of mastery of concepts and creative thinking skills of prospective physics teachers on dynamic electricity. This research is descriptive researcher. The population of this study was 60 prospective physics teachers who were studying at the University of Mataram, West Nusa Tenggara, Indonesia. The number of samples used was 28 students who were taken using a simple random sampling technique. The instrument consists of cognitive tests at levels C1-C3 in the form of multiple choice and tests of creative thinking skills in the form of real-world problems that are open-ended so that they can allow students to provide many solutions to the problems given. There are four aspects of creative thinking skills used in this study, namely; fluency, flexibility, originality, and elaboration. The research data showed that 85.71% of students were able to correctly answer C1 cognitive level questions (remembering), 67.86% of students were able to solve C2 cognitive level questions (understanding), and 60.71% of students were able to solve questions C3 cognitive level questions (applying). Furthermore, for creative thinking skills, the fluency aspect is in the Moderate category with a score of 1.86, and flexibility is in the Low category with a score of 1.14. For aspects of Originality and Elaboration, students are included in the non-creative category with a score of 0.18 and 0.56.

Keywords: Creative Thinking, Mastery of Concepts, Prospective Physics Teacher, Online Learning.

INTRODUCTION

The current era of globalization and technology confronts humans with new challenges and increasingly complex problems. To face increasingly complex challenges and problems, it is not enough for each individual to only have knowledge or basic thinking skills (Low Order Thinking Skills) such as memorizing, remembering, and applying equations but must also be trained in higher-order thinking skills such as critical thinking skills, creative thinking, communication, and collaboration) (Jones & Zanker 2013; Verawati et. al. 2020). Therefore, in the field of education, it is not enough for participants to only be trained to work on simple closed questions that can be solved directly using the equations already in the textbook, but also to be trained to work on open-ended questions whose solutions require activity. more complex thinking.

Higher-order thinking skills are skills to use prior knowledge to reach possible answers in new situations (Heong et al, 2011). Students can think at higher levels when faced with a problem or question so that in the end students can generate ideas to solve problems (Gulistan et. al, 2015). One of the higher-order thinking skills that are very important to develop is creative thinking skills (Chan, 2007; Turkmen, 2015).

Creative thinking skills are important for all professions today. This skill is needed because every profession has its problems that must be solved. Creative thinking skills are an important aspect for every individual to be able to solve a problem and find ideas to solve the problem (Okpara, 2007; Salih, 2010). Without creative thinking skills, someone will use outdated solutions to deal with the problems they face even

though sometimes the solutions offered are not in accordance with the situation and conditions (Kusuma, 2010). This is in line with the statement of Clegg et.al., (2006) which states that creative thinking skills are no longer a compliment but have become the main factor that must be possessed by every individual to survive in the midst of increasingly fierce global competition.

Creative thinking skills are skills to think about many possibilities, use varied ways, use different points of view, think of something new and unusual, and guide us in generating and choosing alternatives (Isaksen, 1995). Mednick defines creative thinking as a process of associating existing ideas with unusual combinations until new original ideas are formed (Treffinger et.al. 2002; Arvyati, 2015; Anwar et al, 2012). Included in creative thinking are synthesizing ideas, generating new ideas, and determining the effectiveness of existing ideas (Safilu, 2010).

Creative thinking skills in all domains, including science, technology, medicine, and art arise from the process of assimilation or combination of old ideas into new ideas that are different from existing ideas. Michalko, (2012) states that creative ideas are always new combinations of old ideas. For example, Einstein discovered the theory of relativity without first discovering the concept of energy, the concept of mass, or the concept of the speed of light. Einstein simply combined those concepts in useful new ways. But what needs to be underlined is that Einstein certainly will not be able to mix concepts without first mastering or understanding the mixed concepts. Therefore, cognitive abilities that include mastery of scientific concepts and facts in learning Physics also need to be trained because they are the basis for training students' creative thinking skills (Hadzigeorgiou et.al. 2012).

Increased mastery of concepts and creative thinking skills are two of the many learning objectives that must be realized in the field of education. Various efforts have been made by educators and policymakers to improve the mastery of concepts and creative thinking skills or in general the 21st-century skills of Indonesian students. However, it seems that the learning achievement of Indonesian students is still below the international average (Simbolon, et.al., 2019). This means that the learning achievement of Indonesian students in general is still very low. This situation has been exacerbated by the COVID-19 pandemic. During the Covid-19 pandemic, most of the learning at school or the university level is done online.

Online learning is a learning system that utilizes the internet network in the process (Hamdarini, 2020). Online learning can be carried out effectively if educators and students use technology well and effectively (Cendra et. al., 2020). So far, online learning at the university level has tried to use various applications or platforms that can support the learning process such as zoom meetings, google classroom, google meet, etc. In fact, most universities in Indonesia have made their own online learning system called SPADA (In-Network Learning System). However, it seems that all of this has not been able to improve student learning outcomes during the COVID-19 pandemic. The results of research conducted by Setyoningrum et. al., (2021) show that online learning during a pandemic can hinder students' cognitive development. In addition, online learning for a long time can make students bored, learning motivation decreases, and can even cause stress students (Cahyani, 2020).

Based on these reasons, it seems important to conduct a study to find out the extent of mastery of concepts and creative thinking skills of prospective physics teacher students after online learning during the covid-19 pandemic. It aims to provide an overview of the learning outcomes of prospective physics teachers in both domains (mastery of concepts and creative thinking skills) which can then be used as guidelines in determining follow-up plans.

METHODS

The method used in this research is the descriptive method. This study was designed to obtain information about the extent of mastery of concepts and creative thinking skills of prospective physics teachers after studying online during the covid-19 pandemic. This study was conducted from August to September 2022. The population of this study was 60 prospective physics teachers who were studying at the University of Mataram, West Nusa Tenggara, Indonesia. The number of samples used was 28 people who were taken using the Simple Random Sampling technique.

The instrument used in this research is a cognitive test level C1-C3 (Low Order Thinking Skill) in the form of multiple choice and a test of

creative thinking skills (high-order thinking skill) in the form of the open-ended problem so as to allow the emergence of many solutions/answers (Wang et.al., 2002).

The indicators of creative thinking skills used in this study used 4 (four) indicators of creative thinking skills that have been developed by Guilford, Torrance, Silver, and Munandar, namely; fluency, flexibility, originality, and elaboration. Fluency is the ability to generate many ideas, ideas, answers, or solutions to a problem. Flexibility is the ability to generate ideas, ideas, approaches, or solutions to a problem from different perspectives or points of view. Originality is the ability to generate unique ideas, ideas, or solutions, think in unusual ways, or be able to make unusual combinations of various elements. Elaboration is the ability to generate ideas, ideas, or solutions that are equipped with detailed and interesting reasons and explanations. (Isaksen, 1995; Silver & Edward, 1997; Treffinger et.al., 2006).

The research data were analyzed using descriptive statistics by looking at the percentage of the number of prospective physics teachers for each category on each indicator of mastery of concepts and creative thinking skills. The formula for determining the percentage is as follows.

$$J = \frac{a}{b}\, x\, 100\%$$

Where J is the percentage of the number of prospective physics teachers who are able to implement indicators of mastery of concepts and creative thinking skills, and a is the number of prospective physics teachers who are able to implement indicators of mastery of concepts and creative thinking skills, and b is the total number of prospective physics teachers.

By considering the number of possibilities, or the diversity of solutions that students would be able to provide based on the characteristics of the problems given, in this study an adaptation of the scoring and categorization techniques that had been made by CCSS ELA, (2013) was carried out. The scoring technique for creative thinking skills in this study can be seen in the following table.

Table 1. Techniques for scoring creative thinking skills

Category	Fluency	Flexibility	Originality	Elaboration.
High	Can provide ≥ 3 relevant solutions	Can provide ≥ 3 relevant solutions and from different points of view	Can provide ≥ 3 relevant and unique solutions	Can provide ≥ 3 relevant, detailed, and interesting explanations of each given solution.
Moderate	Can provide 2 relevant solutions	Can provide 2 relevant solutions and from different points of view	Can provide 2 relevant and unique solutions	Can provide 2 relevant, detailed, and interesting explanations of each given solution.
Low	Can only provide 1 relevant solution	Can only provide 1 relevant solution	Hanya dapat memberikan 1 solusi yang relevan dan unik	Can only provide 1 relevant, detailed, and interesting explanation of each given solution.
Not Creative	Unable to provide relevant solutions	Unable to provide relevant solutions	Unable to provide relevant and unique solutions	Unable to write a relevant, detailed, and interesting explanation of any given solution.

Creative thinking skills categorization techniques can be seen in the following table.

Table 2. Categories of creative thinking skills

Average score	Category
$2{,}25 < \boldsymbol{x \leq 3{,}00}$	High
$1{,}50 < \boldsymbol{x \leq 2{,}25}$	Moderate
$0{,}75 < \boldsymbol{x \leq 1{,}50}$	Low
$0{,}00 \leq \boldsymbol{x \leq 0{,}75}$	Not Creative

RESULTS AND DISCUSSIONS

Data on the concept of mastery of prospective physics teachers can be seen in the graph below.

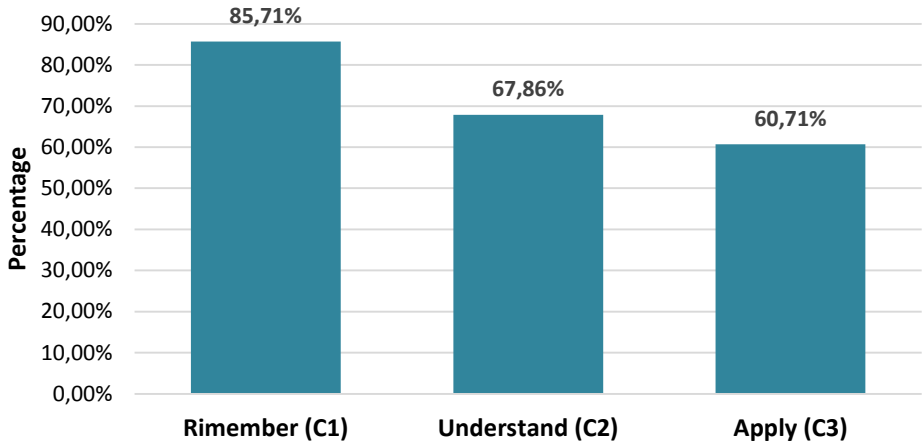
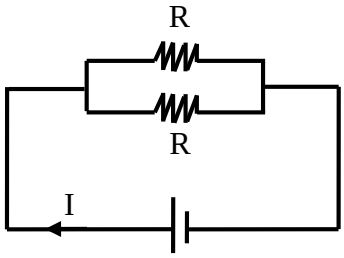


Figure 1. Percentage of prospective physics teachers who answered correctly

The data in the graph above shows that on average as many as 85.71% of prospective physics teachers (answer correctly the questions at level C1 (remember). That is, most of them are able to answer questions at level C1 correctly. For the cognitive level C2 (understand), the average percentage of students who answered correctly was 67.86%. That is, there is still an average of 32.14% of those who do not understand the concept well. One of the examples of questions given to students is to find out the extent of their understanding of the concept of series and parallel circuits by asking students to identify the correct answer from the 5 answer choices given by referring to the following series:



Gambar 2. Increased understanding of student concepts in terms of cognitive style

As many as 57.14% of students answered this question correctly. As many as 17.86% of the students stated that the total resistor value of the circuit was greater than the value of each of its constituent resistors. This answer seems to come from students who think that the total resistance of a circuit is the sum of the two resistances of its constituents. In addition, 14.29% of students think that the total voltage in the circuit is greater than the voltage flowing through each resistance. The remaining 10.71% of students answered with other answers.

For the cognitive level C3 shows that an average of 60.71% can answer the question correctly. That is, there are still as many as 39.29% who have not been able to apply their equations and understanding to solve simple problems surrounding the dynamic electricity sub-discussion. This is thought to be because students rarely practice solving simple problems during online learning

Furthermore, the profile of the creative thinking skills of prospective physics teachers can be seen in the table below.

Table 1. Profile of the creative thinking skills of prospective physics teachers

Indicators of Creative Thinking	Score	Category
Fluency	1,86	Moderate
Flexibility	1,14	Low
Originality	0,18	Not Creative
Elaboration	0,56	Not Creative

The data in the table above shows that the fluency aspect is in the moderate category with a score of 1.86. This aspect is the largest percentage compared to the other three aspects. Fluency is the ability to generate many ideas, ideas, answers, or solutions to a problem. Only 7.14% of students were able to provide solutions more than or equal to 4 (≥ 4). A total of 28.57% of students gave 3 solutions and 32.14% of students gave 2 solutions, and the remaining 32.14% of students were only able to give 1 or less than one (≤1) solution to the given problem. The form of questions to measure students' creative thinking skills can be seen in Figure 2 below.

The Flexibility aspect is in the low category with a score of 1.14. Flexibility is the ability to generate ideas, ideas, approaches, or solutions to a problem from various perspectives or different points of view. For the Flexibility aspect, only 39.28% of students were able to provide 2 different points of view. A total of 35.71% were able to provide only one point of view. The average student only focuses on finding solutions by engineering resistors at the nearest electronics store and by considering cost efficiency or resistor prices. Almost no students have a different point of view by trying to design LED lamps as a substitute for resistors. Of course, this will be better in terms of bright lights and price efficiency. The limited number of points of view that arise is due to the limited mastery of concepts possessed by students.

Problem:

After your first project is successful, this time you plan to replace your study lamp with a capacity of 6 batteries with each battery having a voltage of 1.5 volts. Incidentally, you still have 12 LED lights with 20mA/2V specifications. You realize that if you only use one LED lamp, the LED lamp will be damaged if it is assembled with 6 batteries. Therefore, to avoid damage, you must engineer the circuit and/or add a Resistor to the electrical circuits. But unfortunately, the Resistor you are looking for is not available at the nearest electronics store but is only available in stock for 50, 60, 100, 120, 150, 500, and 600 Resistors. Before buying, as a physics student, you are trying to identify which Resistors could be used and how many of each resistor would have to be purchased to be equivalent to a Required resistor. If all Resistors have the same price, which is IDR. 250/piece, then:

Question:

1). Write down the various solutions you offer to solve the problems above.? Explain why you think so...!

Number	Solutions	Explanation
1		
2		
3		
etc		

2). From the various solutions that you have offered, determine the best solution from the above equation.? Explain why you think so...!

Number	Best solution	Explanation
1		

Figure 3. Open-ended problem to measure creative thinking skills

The Originality aspect received the lowest score from the other three aspects, namely 0.18 in the non-creative category. Originality is the ability to generate unique ideas, ideas, or solutions, think in unusual ways or be able to make unusual combinations of various elements. Low aspect. The low aspect of Originality is due to the low aspect of flexibility or the lack of diversity of perspectives that come from students. This is due to the low mastery of concepts possessed by students.

The last aspect is elaboration. Student skills in elaborating the solution of a problem are low with a score of 0.56. The aspect of

elaboration or detailed thinking is the student's ability to detail and find various approaches to problem solving. Students' elaboration skills are still very low. They are only able to detail the information already implied in the problem. Students have not been able to analyze, comment on, and evaluate an idea, look for the advantages and disadvantages of an idea and then detail the solutions for solving and improving the shortcomings of ideas that arise. The ability to detail, of course, is strongly supported by a deep mastery of concepts.

CONCLUSION

The results of the data analysis showed that the mastery of students' concepts for low cognitive levels (low-order thinking skills) was quite good. This means that most students are able to work on C1-C3 questions. However, what needs to be considered is the students' creative thinking skills. Based on the results of the data analysis shows that the average creative thinking skills are very low. Students are only moderate in the fluency aspect, while the flexibility, originality, and elaboration aspects are still very weak. This means that students are only able to come up with various solutions from the same point of view. In this context, students are only able to provide solutions by only paying attention to the suitability of the value of the barriers given. It is rare for them to think about other things such as the aspect of effectiveness without using obstacles but by engineering the LED circuit. Likewise for the aspect of cost efficiency, less than half a percent of those who think from the point of view of cost, art, and other points of view. Therefore, very few of the students are able to provide unique (original) solutions to the given problems.

ACKNOWLEDGMENT

The research team would like to thank the head of the study program for giving permission to conduct research at the Physics Education Study Program at the University of Mataram.

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