Creative thinking skills of prospective physics teacher

R Rizal1,2*, D Rusdiana2, W Setiawan3, and P Siahaan2
1Departemen Pendidikan Fisika, Universitas Siliwangi Jalan Siliwangi No 24, Tasikmalaya 46115, Indonesia
2Sekolah Pascasarjana, Universitas Pendidikan Indonesia Jalan Dr. Setiabudi No. 229, Bandung 40154, Indonesia
*Corresponding author’s e-mail: rahmatrizal@unsil.ac.id

Abstract. The 21st century demands high quality human resources that can compete in global competition. The good quality human resources come from the good quality education process which train learner with skills to solve problems, to find alternative solutions in problem solving, and to think reflectively. These skills are included in creative thinking skills which is important to be developed for prospective physics teacher. This study aimed to identify the creative thinking skills of prospective physics teacher who have attended lectures of general physics, basic physics, and physics for school. By using the creative thinking skills test and interview, the researcher tried to explore four aspects of creative thinking consisting of fluency, flexibility, originality, and elaboration. The results of this study indicated the creative thinking skills of prospective physics teacher were in the low category with mean was 43.75 from a maximum scale of 100. The details of the means of each aspect of creative thinking skills were expressed as follows fluency (57), flexibility (43), originality (34), and elaboration (41). The low level of creative thinking skills of prospective physics teachers is thought to be due to lecture activities that do not provide an opportunity to practice creative thinking skills.

1. Introduction
The development of science and technology in the 21st century took place very quickly [1]. This has resulted significant changes in various fields of life and generate new era of information and globalization. This condition also impact to teachers who continuously face challenges in increasing professional responsibility and complexity of tasks [2-3]. As a result, each individual must have the number of competencies that provide an added value. According to statement of Partnership for 21st Century Skills (P21) that the number of competencies required to face the challenges of modern life in the 21st century is called "The 4Cs" - communication, collaboration, critical thinking, and creativity [4].

Today's modern life we enjoy is inseparable from the scientific aspect. Various inventions, both technology and theory, always be judged in the scientific aspect. The scientific inventions reflect the creativity of the researchers or scientist working in their day. Physics as a part of natural science which learn natural objects and phenomena cannot be separated from thinking skills because it cannot be understood without thought processes. One kind of thinking skills that is important to be improved in physics learning is creative thinking skills [5-7]. The study conducted by Trilling and Fadel shows that fresh graduates from both high school and college do not have good competence in terms creative thinking skills [8].
Analysis result of the lecture assignments was found that 65% of students adopted sources by the internet without doing any recreation in completing the lecture assignments. This condition was suspected because the creativity of students in expressing ideas was still weak. This was thought to indicate the low of creative thinking skills of prospective physics teacher. Based on the importance of creative thinking skills for physics teachers in 21st century and the analysis result of prospective physics teacher's assignments, a study is needed to be conducted. This study aimed to find out the profiles of prospective physics teacher’s creative thinking skills, factors allegedly caused to creative thinking skills, and correlation creative thinking skills with cognitive ability.

Creative thinking is cognitive activity in finding solutions to solve a problem [9]. Neuman stated that creative thinking is a way to generate new information and unique final product [10]. Creative thinking is the ability to answer problems based on existing data / information with various alternative answers. The answers given show originality, flexibility, fluency, and elaboration. Fluency is the ability to express clearly many correct ideas as much as possible. Flexibility is the ability to issue various ideas based on various perspectives. Originality is the ability to issue unique and unusual ideas, for example those that are different from those in books or others opinion. Elaboration is the ability to explain the factors that influence situation and add its detail so that they are more valuable.

Munandar [11] described the indicator of creative thinking skills aspects as shown in Table 1.

| No | Aspect of creative thinking | Indicators |
|----|-----------------------------|------------|
| 1  | Think smoothly (fluency)    | ▪ Thinking of more than one answer.  
|    |                             | ▪ Respond the questions with many alternative questions |
| 2  | Think flexibly (flexibility)| ▪ Generate ideas, answers, or varied questions.  
|    |                             | ▪ See a problem from different perspective.  
|    |                             | ▪ Look for many different alternatives or directions.  
|    |                             | ▪ Able to change the way of approach or thought. |
| 3  | Think originally (originality)| ▪ Reveal new and unique ideas  
|    |                             | ▪ Think of unusual ways to express their selves |
|    |                             | ▪ Able to make unusual combinations of parts or elements. |
| 4  | Think elaborately (elaboration)| ▪ Work and develop a product or idea.  
|    |                             | ▪ Add or detail of object, idea or situation so that it becomes more interesting |

The creative thinking skills need to be built using creativity. Hurlock stated creativity is a person’s ability to generate compositions, products, or any ideas that are basically new and unknown [12]. It can be an imaginative activity or synthesis of thought whose results are not just summaries. It may include the formation of new patterns and the combination of information obtained from previous experience and implementation old relationships into new situations may shape new correlations.

2. Method
This research was a descriptive study to get the description of creative thinking skills of prospective physics teacher in the physics education department at a university in Tasikmalaya. The respondents involved in this research were 20 prospective physics teachers who are taking physics for school in the even semester 2018/2019 academic year. They are consisted five males and 15 females. Six respondents are 19 years old and 14 respondents are 20 years old. The respondents were selected by consideration they have learned physics concepts in many subjects (general physics and basic physics) so that they were considered to have good mastery in physics concepts.

The study was conducted in three stages, namely planning, implementation, and reporting. At each stage, the activities were carried out as shown in figure 1.
Instruments used in this study were three types. They were a test, a questionnaire, and a guided interview. Test was used to measure four aspects of creative thinking skills (fluency, flexibility, originality, and elaboration). Test can be developed in two types, objective test and essay test [13-14]. The researcher chose essay test so the respondents could reveal their idea openly. The essay test consists of 12 questions and was developed by three main problems. The creative thinking skills test has been validated by some experts and has high validation. Means of creative thinking skill score which gotten by the test were classified into five categories as shown in Table 2.

| No | Mean       | Category   |
|----|------------|------------|
| 1  | 0.0 ≤ x ≤ 30.0 | Very low   |
| 2  | 30.1 ≤ x ≤ 55.0 | Low       |
| 3  | 55.1 ≤ x ≤ 70.0 | Moderate  |
| 4  | 70.1 ≤ x ≤ 85.0 | High      |
| 5  | 85.1 ≤ x ≤ 100.0 | Very high |

The questionnaire and guided interview were used to analyze lecture activities (included general physics and basic physics) that have been attended by prospective physics teacher. The questionnaire used Likert scale which described level of agreement or disagreement on a symmetric agree-disagree scale for a series of statements. The range scale used for a single statement are 0 = strongly disagree, 1= disagree, 2 = moderate, 3 = agree, and 4 = strongly agree. The data collected by the questionnaire further explored by interview. The guided interview could give information to analyze profile of creative thinking skills of prospective physics teacher. There were five main questions consisted of: (a) The learning method applied in the lecture, (b) The learning media used, (c) The skills were built from the lecture, (d) The motivation of lectures that are built, and (e) The assignments and evaluations used. Questions could be developed according to the answers stated by the respondent.

3. Result and Discussion
The creative thinking skills observed in this study cover four aspects of skills, namely fluency, flexibility, originality, and elaboration. Based on the results of the essay test given to the prospective physics teachers, unexpected conditions were found. Their creative thinking skills were in low category. By 100 points as the highest score, the mean of creative thinking skills for all respondents was 43.75. The means of prospective physics teacher creative thinking skills for every aspect are shown in figure 2.

Most of creative thinking skills aspects were in the low category except the fluency which is in the moderate category. The low of prospective physics teacher creative thinking skills is inseparable from how the lectures take place. Interviews conducted directly to respondents gave description of learning activities in both general physics and basic physics. In general physics and basic physics lectures,
learning were carried out with conventional methods. The lecturers have the biggest role in learning.

They explained the subject in one direct and sometimes they provided time for prospective physics teacher discuss about unclear subject. Lecturers delivered physics material with using power point media which generally contained brief material of study being discussed. Rarely, were there animations or simulations displayed along lectures. There was physics experiment using the cook book method which focuses on verifying concept.

The questionnaire result showed that most of respondents are less interested in learning activities and are not motivated to learn such as shown in the figure 3. Totally, 85 % respondents stated disagree and strongly disagree to the statement that learning activities in basic physics and general physics lectures are interesting and motivated them to learn.

Based on the respondent explanations, we can find out that there was no lecture activity that provides optimal chance for prospective physics teacher to train their creative thinking skills. The students were less interested in learning activities and are not motivated to learn. Basically, everyone has creative thinking, but to develop it, teachers and schools need a supported learning approach [15] and also need to create classroom learning atmosphere oriented to creative thinking skills [16]. A conducive learning atmosphere will result an environment that provides opportunities for students to develop their creative thinking skills. It is in accordance with the opinion of Sternberg which states that the learning environment is a source needed for creative thinking skills [17].

Carin and Sund [18] also suggested that to create creativity in learning need to pay attention to the following aspects: (a) developing high trust and minimizing fear, (b) encouraging the occurrence of free communication, (c) making limitation on goals and individual assessments by students; (d) control that is not too strict [18]. The learning activity that trains creativity needs creative processes using five stages of activity consisting of:

a. Preparation. Students involve in interesting problems that trigger their curiosity
b. Incubation. Students instill these ideas in their thinking and then make unusual connections.

c. Insight. Learners experience "Aha!" When all riddle seem to fit in with each other.

d. Evaluation. Learners must decide whether ideas are valuable and worthy to use. They must think, "Is the new idea clear?"

e. Elaboration. This last step often covers the longest time and involves the most difficult work [19].

The biggest mean for aspects of creative thinking skills appears in the fluency with mean 57. This condition was influenced by the learning activities that provide discuss time. In discuss session, prospective physics teacher got chance to ask some thing related to the concept. The student has opportunity in asking subject that were not understood or contextual problem or phenomena connecting to the concept. In accordance with what the UK's Qualifications and Curriculum Authority in Harris suggest, how teachers play their role in developing students creativity by placing five creative behaviours: asking and challenging, making connections and looking at relationships, imagining what might, openly exploring ideas, and critically reflect ideas, actions, and results [20]. By five suggestions, just one suggestion that often trained in the physics learning. It is asking and challenging. So that, it is very reasonable if the fluency has the biggest mean in creative thinking skills.

The lowest mean is in the originality with mean 34. The lecture assignments that are widely used in lectures are more mathematical problem solving and related to concept. The source of assignment came from the main reference books. The assignment was less of activities and thought in contextual and conceptually problem solving that can help in developing creative thinking skills. This has become one of the factors that resulted in low originality skills because there is no enough opportunity for conveying students’ ideas. Whereas De Bono stated that creative problem solving training can help improve creative thinking skills [21].

The creative thinking skills test used in this study involves the concept of being able to solve problems so researchers try to trace the cognitive abilities of students through the results of evaluations of basic physics and general physics lectures. Based on the results of cognitive abilities of prospective physics teacher in general physics and basic physics lectures and tests of creative thinking skills, it was found a tendency that their creative thinking skills are supported by their cognitive abilities. Students who academically have good cognitive abilities when attending lectures in general physics and basic physics are found to have creative thinking skills that are better than the others. The researcher tried to find out the correlation between cognitive abilities score and creative thinking skills score using Pearson’s product moment correlation.

Table 3. Pearson’s product moment correlation between cognitive abilities and creative thinking skills

| Cognitive ability | Creative thinking skills |
|-------------------|-------------------------|
| **Pearson Correlation** | 1 | .618** |
| Sig. (2-tailed) | | .002 |
| N | 20 | 20 |
| Creative thinking skills | **Pearson Correlation** | 1 |
| Sig. (2-tailed) | .518** | .002 |
| N | 20 | 20 |

Table 3 shows that the correlation of cognitive abilities and creative thinking skills has a significance value of 0.002 < 0.05 and Pearson correlation 0.618. It shows that there is a high positive correlation between cognitive ability and creative thinking skills. Daskolia [22] stated that creativity as a result of creative thinking is inseparable from cognitive abilities that are collaborated with various other components to find social solutions from problems. So it is very natural if the person's cognitive ability are good then his thinking skills are also good.
4. Conclusion

The creative thinking skills of prospective physics teacher are still in the low category. Three aspects which include flexibility, originality, and elaboration are in the low category, while the fluency aspect is in the moderate category. The difference in the categories of each digital aspect of literacy was influenced by a number of activities and assignments in lectures that have been carried out in various lectures that do not provide opportunities for prospective physics teachers to practice creative thinking skills. The creative thinking skills observed in this study have high correlation with cognitive abilities.

5. References

[1] Rizal R, Setiawan W and Rusdiana D 2019 Digital literacy of preservice science teacher. InJournal of Physics: Conference Series 1157 2 022058
[2] Harris A and Ammermann M 2016 The changing face of creativity in Australian education Teaching Education 27 1 103–113
[3] Simon S E 2013 Chaos of textures or ‘Tapisserie’? A model for creative teacher education curriculum design Australian Journal of Teacher Education 38 11 87–102
[4] The Partnership for 21st Century Skills 2008 21st Century Skills, Education and Competitiveness a Resource and Policy Guide
[5] Chan D W 2007 Creative Teaching in Hong Kong Schools: Constraints and Challenges Hong Kong Educational Research Journal 22 1 1-11
[6] Pacific Policy Research Center 2010 21st Century Skills for Students and Teachers (Honolulu: Kamehameha Schools, Research & Evaluation Division)
[7] Turkmen H 2015 Creative Thinking Skills Analyzes Of Vocational High School Students Journal Of Educational And Instructional Studies In The World 5 1 74-84
[8] Trilling B and Fadel C 2009 21st Century Skills: Learning for Life in Our Times (San Francisco, California: Jossey-Bass/John Wiley & Sons, Inc.)
[9] Adams K 2005 The Sources Of Innovation On Creativity A Paper Commissioned by The National Center On Education And The Economy For New Commision on the Skills Of The American Workforce. National Center On Education and The Economy
[10] Neuman D B 1993 Experiencing elementary science (California: Wadsworth Publishing Company)
[11] Munandar U 1999 Development of Gifted Child Creativity (Jakarta: PT Rineka Cipta)
[12] Hurlock E B 1999 Child Growth vol. 2 (Jakarta: Erlangga)
[13] Coffman W E 1966 On The Validity Of Essay Tests Of Achievement Journal of Educational Measurement 3 2 151–156
[14] Walstald E W and Becker E W 1994 Achievement Differences on Multiple-Choice and Essay Tests in Economics Research on Economics Education 84 2 193-196
[15] Tosun C and Taskesenligil Y 2011 Journal of Turkish Science Education 9 1 104-125
[16] Slavin R E 2009 Educational Psychology Theory and Practice. Eighth edition volume 2. (Jakarta: PT Macanan Jaya Cemerlang)
[17] Sternberg R J 2006 The nature of creativity Creativity research journal 18 1 87-98
[18] Carin A A and Sund R B 1970 Teaching modern science 3th ed. (Ohio: A Bell & Howell Company) p. 307
[19] Santrock J W 2011 Educational Psychology (Newyork: McGraw-Hill) p. 201
[20] Harris A dan de Bruin L R 2018 Training teachers for twenty-first century creative and critical thinking: Australian implications from an international study TeachingEducation 29 3 234-250
[21] De Bono E 2007 Thinking revolution (Bandung, Indonesia: Mizan Main Media)
[22] Daskolia M, Dimos A and Kampylia P G 2012 International Journal of Environmental & Science Education 7 269-290