Profile of pre-service physics teachers' creative thinking skills on wave and optics course

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Abstract. Interference and diffraction are topics that are generally dominated by abstract concepts and concepts that states the name of a process that was commonly causes learning difficulties. This study aims to describe the profile of pre-service physics teachers’ (PPTs) thinking styles and creative thinking (CrT) skills on wave and optics courses. The study is a survey involved 46 fifth semester PPTs at one of the universities in Ternate city. Data related to PPTs’ thinking styles were collected through the Yanpiaw Creative-Critical Styles Test. Data related to PPTs’ CrT skills were collected through tests of CrT skills. The data of CrT skills were analyzed descriptively. Results revealed that the profile of CrT for the group of PPTs with creative thinking style can be categorized as high, while for the group of PPTs with balance, critical and superior critical thinking style can be categorized as low.

1. Introduction
Interference and diffraction are topics that are generally dominated by abstract concept and concept that states the name of a process that was commonly causes learning difficulties. These two topics are topics that still lack competence. Preliminary research has shown that the lack of concept mastery of pre-service physics teachers (PPTs) at the study site causes by the low motivation to be engagement in the learning activities. The implementation of learning processes is still dominated with conventional methods, more likely to be teacher centered. This has an impact on the lack on empowering PPTs’ creative thinking (CrT) skills [1].

CrT is appearing to be concentrated in the divergent-thinking category, that kind of thinking to produce a variety of solutions to a given problem [2]. CrT is applying four concepts; as fluency, flexibility, originality and elaboration [3]. Torrance argues that CrT as a process which involves the elements of originality, fluency, flexibility and elaboration [4]. Guilford and Torrance define four characteristics of CrT; as a) originality; refer to the uniqueness of any given response, b) elaboration;
the ability to elucidate on a particular subject that shown by the number of addition and details that can be made to some simple stimulus to make it more complex, c) fluency; the ability to produce an abundance of ideas and d) flexibility; an individual’s ability to shift his/ her mental set when the circumstance require it, or the tendency to view a problem instantly from a variety of perspectives [4].

CrT is thinking patterned in a way that lead to creative results. There are six general principles of CrT; e.i. a) CrT involves aesthetic as much as practical standards, b) CrT depends on attention of purpose as much as results, c) CrT depends on mobility more than fluency, d) CrT depends on working at the edge more than at the center of one’s competence, e) CrT depends as much on being objective as on being subjective, and f) CrT depends on intrinsic, more than extrinsic, motivation [5].

CrT is an ability based on available data or information, finding many possible answers to a problem, where the emphasis is on quantity, usability and answering diversity [6]. CrT skills are the developing or finding skills towards original ideas, aesthetic and constructive, that relate to viewpoints and concepts and emphasize intuitive and rational thinking especially in the use of information and materials to bring up or explain with the original perspective of thinkers [7].

CrT is one of the most important skills to be trained for PPTs. CrT is the aptitude characteristic of the creativity that is related to cognition, with the thinking processes, that includes fluency, flexibility, originality, elaboration and evaluation. Creativity is something that is important in life because: a) with creativity, people can manifest themselves, where self-realization is one of the basic needs in human life, b) Guilford argued that CrT is lack of attention in formal education, c) engaging yourself creatively is not only beneficial, but also gives satisfaction to individual, d) creativity allows people to improve their quality of life [6].

Wave and optics course is one of the courses that can be used as a way to develop PPTs’ CrT skills. Previous research has been done related to the development of CrT skills in physics learning such as implementation of problem based learning [8, 9], science process skills approach [10], portfolio-based learning [11], project-based learning [12], discovery learning model [13], project creative learning [14, 15], and development of worksheet based on multiple intelligences [16].

Mapping the thinking style and CrT skills are the first step in improving the CrT skills of PPTs in the research population. This profile of PPTs will be used as a reference in determining the appropriate action plan for improving the PPTs’ CrT skills.

2. Method

This is a survey to describe the profile of PPTs’ thinking styles and CrT skills on wave and optics courses. This survey involved 46 PPTs that consist of 5 male, 41 females and the average age is 19.7 years old. PPTs are the students of the fifth semester who are enrolled on waves and optics course at one of the universities in Ternate city.

The instrument for measuring PPTs’ thinking styles using the Yanpiaw Creative-Critical Styles Test that consist of 33 multiple choice questions and 1 essay. The PPTs’ thinking style scores are interpreted on the YCreative-Criticals Scoring indicator. The thinking style can be classified into five categories; as superior creative thinking (ScreT) style, creative thinking (CreT) style, balance thinking (BT) style, critical thinking (CriT) style and superior critical thinking (ScriT) style [4, 17]. While the instrument for measuring PPTs’ CrT skills was designed on the essay form that aimed to measuring fluency, flexibility, originality and elaboration indicators. The data of CrT skills were analyzed descriptively.

3. Result and discussion

The profile of PPTs’ thinking style and CrT skills on wave and optics courses can be shown on figure 1 and 2. Based on figure 1, the profile of PPTs’ thinking style in the study population can be classified as Cret style (4%), BT style (13%), CriT style (78%) and ScriT style (4%). While based on figure 2, generally the profile of CrT skills for the group of PPTs’ with CreT style can be categorized as high (66.8%), BT style as low (40.0%), CriT style as low (35.8%) and ScriT style as low (29.3%).

For fluency indicators, PPTs' are required to; a) mentions many examples of everyday phenomena associated with thin-film interference, b) mentions many ideas related to Young’s double-slit experiment
using yellow light, c) provides many ways or suggestions regarding a double-slit experiment that aims for determining the value of the slit separation and d) create various superposition graphs of two waves with the magnitude of amplitude are 50 cm and 100 cm that were resulting destructive interference. In the fluency indicator, the profile CrT skills for the group of PPTs’ with CreT style can be categorized as medium (50%), BT style as medium (44%), CriT style as low (35%) and ScriT style as low (33%).

For flexibility indicators, PPTs’ are required to: a) provide various interpretations toward the sketch of Young double-slit experiment, b) produces many alternatives related to different-phase of monochromatic rays that was come perpendicularly to the thin-film in order to destructive interference and c) create various superposition graphs of two waves that were resulting destructive interference (the value of amplitude and difference-phase of two waves can be varied). In the flexibility indicators, the profile CrT skills for the group of PPTs’ with CreT style can be categorized as medium (50%), BT style as low (33%), CriT style as low (33%) and ScriT style as very low (17%).

For originality indicators, PPTs’ are required to: a) think of ways that can be done to enlarge the distance between two bright fringes sequences on the screen, b) making various combinations of the data of Young's double-slit experiment such as the distance of screen from the slit (L), wavelength (λ), double slit separation (d) that produce the distance between bright fringes on the screen are 0.2 mm. In the originality indicator, the profile CrT skills for the group of PPTs with CreT style can be categorized as high (67%), BT style as low (33%), CriT style as low (21%) and ScriT style as very low (0%).

For elaboration indicators, PPTs’ are required to develop or enrich ideas related to the result of the Young's double-slit experiment based on the figure sketch presented. In the elaboration indicator, the profile CrT skills for the group of PPTs with CreT style can be categorized as very high (100%), BT style as medium (50%), CriT style as medium (54%) and ScriT style as high (67%).
The above description shows that the learning activities that have been implemented are still considered not optimal in developing PPTs’ CrT skills for all groups of thinking styles. Previous research indicates that gender and thinking style were significant factors of CrT abilities [18]. Other studies show a significant relationship between CrT and students’ academic achievements. However, the relationship could be altered when different level of academic achievement is examined and when CrT measure employed [19].

By knowing of PPTs’ thinking styles, we can identify the strengths and weaknesses of PPTs’ thinking [4]. In addition, we can plan what actions are appropriate for improving the weaknesses and enrich the strengths of PPTs’ thinking.

4. Conclusion

The profile CrT skills for the group of PPTs with CreT style can be categorized as high, while for the group of PPTs with BT, CriT and ScriT style as low. For the group of PPTs with BT style, the indicator of flexibility and originality are still categorized as low. While for the group of PPTs with CriT and ScriT style, the indicators of CrT are still weak that is on the indicators of fluency, flexibility and originality. The results of this survey indicate that it is necessary to design a waves and optics course that can develop CrT skills for all PPTs with various types of thinking styles.

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