Growth of student mathematical creativity as part of 4C competence for entering the 21st century

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Abstract. The purpose of this article is to examine the lecturers' efforts to foster students' Mathematical Creativity as part of the 4C Competency to enter the 21st Century, which students must have. The review of this article is based on the results of the Dissertation research conducted by a qualitative approach. The subject of this research, by taking 6 students of Mathematics Education of FMIPA of UNNES. The main activities of this basic research were: (1) identifying the scaffolding stages by the lecturer to foster students' Mathematical Creativity; (2) analyse the fundamental thinking to foster students' Mathematical Creativity through the provision of open ended problems. The results: (1) The scaffolding stage was identified by the lecturer to foster students' Mathematical Creativity. (2) Obtained the results of an analysis of fundamental thinking to foster the students' Mathematical Creativity through the provision of open ended problems. Suggestion: To prepare the students as teachers candidate in the 21st century, students need to grow their Mathematical Creativity competencies. Students must also be trained to be able to create of open ended problems based on HOTS.

1. Introduction
Education as the spearhead of the progress of a nation should provide services that are in line with the demands of the times. Someone who lives in the 21st century era is required by relevant skills that must be mastered in order to be able to adapt and contribute. The demands of the 21st century's increasingly competitive capabilities, according to [1] require four competencies, namely: Critical Thinking, Creativity, Collaboration, and Communication. Education as the bearer of the reformative and transformative roles must be able to prepare students to master these various skills. The 21st century skills demand that is applied to schools in Indonesia is simplified to become a 4C competency, namely: critical thinking, creativity, collaboration, and communication.

The application of these essential competency principles is expected that lectures in the Mathematics Education Study Program produce graduates of teacher candidates who are ready to face the 21st century. In addition, assessment has a role to stimulate learning outcomes, one of which is to build creative attitudes. One of 4C competencies in mathematics, is mathematical creativity. In forming mathematical creativity, open ended problems based on Higher Order Thinking Skills (HOTS) are needed.

The problems that will be examined and resolved are as follows. (1) How to identify scaffolding stages by lecturers to foster students' Mathematical Creativity. (2) How to analyze fundamental thoughts to foster students' Mathematical Creativity through the right solution of the open ended problems?
The objectives to be achieved are as follows. (1) To identify the scaffolding stage by the lecturer in growing students' Mathematical Creativity. (2) Obtaining the results of fundamental thought analysis to foster Mathematical Creativity of students through the right solution of open ended problems.

In this era, the students Mathematics Education Study Program as teacher candidates need to have a number of competencies. Broadly speaking, there are 3 groups of competencies needed by student in this era, namely: (1) have good character, namely religious character, nationalism, independent, mutual cooperation, and integrity; (2) has 4C capabilities, namely critical thinking, creativity, collaboration, and communication; and (3) mastering literacy includes thinking skills using knowledge sources in print, visual, digital and auditory forms. The study in this article emphasizes solutions to build students' Mathematical Creativity competencies through lectures on Graph Theory. Thus, the research instrument is also directed at international standard problems, namely open ended problems that are Higher Order Thinking Skills.

Furthermore, [2] wrote that to define creative students need to understand what is meant by creativity. Although there is no agreement on the definition of creativity, [3] argued that experts in the field of creativity have agreed that the creativity of students has three main elements, namely: (1) There are products, actions, or ideas that must be the original work of students themselves. (2) Students succeed in achieving the desired goal. (3) The creative power generated is obtained through good means.

By having high mathematical creativity, it is hoped that someone can use it to solve problems in their lives. This thinking is in line with the opinion [4], which stated that mathematics has a relationship with the real world and humans will not be able to master the world if humans do not master mathematics. According to [5], the core in studying mathematics is mathematical creativity. Furthermore, according to [6], a student is said to have mathematical creativity if the student has the ability to produce work on an assignment independently complete and right, student is able to work on problems or assignments with several different correct answers, or student succeed in finding different algorithms in completing a task.

To build students' Mathematical Creativity abilities, assessment instruments are directed at international standard problems, which are open ended problems based on HOTS. This article, is the result of analysis of fundamental thoughts to foster students' Mathematical Creativity through giving open ended problems based on HOTS. According to [7], the giving of open ended problems based on HOTS in assessing learning outcomes can train students to hone their abilities and skills in accordance with the demands of 21st century competence above. Through assessment based on HOTS problems, critical thinking skills, creativity, and self-confidence will be built through training activities to solve various real problems in daily life.

In this 21st century era, the benefit of having mathematical creativity is to be able to understand a complex problem, and be able to connect information to one another, so that finally various perspectives and ways of finding solutions to problems arise. According to [8], with mathematical creativity a person will have the ability to reason, understand, and be able to make complex choices namely understanding the interconnection between systems, compiling, expressing, analyzing, and solving problems. So, to foster mathematical creativity through mathematics education, students need to be accustomed to solving mathematical problems whose solutions require the ability to reason, understand, and be able to make complex choices namely understanding the interconnection between systems, composing, expressing, analyzing, and solving problems with various alternatives.

According to [9], competence or creativity is the ability to implement and create new ideas to others; being responsive to students' perspectives in creating new ideas or new ways. [10] wrote that students' creativity in facing the 21st century in the industrial era 4.0 will greatly depend on the creative thinking of students in the future, namely the process of one's intelligence / students in creating new ideas. Creativity that can produce new discoveries (and are usually economically valuable) is often referred to as innovation. Whereas [11] and [12] wrote that to foster a mathematical creativity in students, then mathematical problems need to be given to students is the problems that have an open ended character and who are relatively more difficult.
2. Methods

2.1. Approach of research
The method used a qualitative approach. In this study, researcher use natural data as a source of direct, descriptive, and important data processes is to get accurate results in answering the all of research problems.

2.2. Subjects of research and locations
The subjects of this research were 6 students of the Mathematics Education Study Program who took classes in Discrete Mathematics lectures. Research locations in the Department of Mathematics of Mathematics and Natural Sciences Faculty of Universitas Negeri Semarang.

2.3. Data analysis
According to [13] and [14], the activities in qualitative data analysis are carried out interactively and last until it is completed, so that the data is in accordance with its objectives. Researchers' activities in data analysis include: data reduction, data presentation, data interpretation, and conclusions.

2.4. Data validity techniques
In this research, the data collection instruments are the researchers themselves. The data collected is tested for validity in order to obtain truly objective data. There are several data validity testing techniques that are used according to its needs, such as extending the research period, increasing research persistence, reviewing research subjects, and triangulation. The triangulation consist of: (1) theory triangulation, (2) triangulation of the researcher's findings. The triangulation results are then recapitulated in 5 categories, namely: (1) Very Good, (2) Good, (3) Moderate, (4) Lacking, and (5) Very Lacking. The determination of that category above depends on the result of assessment, instrument, interview , and the results of the triangulation by researcher.

3. Results and Discussion

3.1. Research products
The results of the study are as follows.
(1) The scaffolding stage is identified by the lecturer to foster Mathematical Creativity. Scaffolding stages conducted by lecturer: Lecturer gives lecture material according to RPS contents, lecturers start giving examples of Open Ended problems based on HOTS, students are guided proportionally to solve problems, then students are trained independently in solving open ended problems based on HOTS.
(2) The results of analysis of fundamental thoughts are obtained to foster Mathematical Creativity of students through the provision of the open ended problems based on HOTS. The basic idea, to foster Mathematical Creativity, students need to be given open ended problems based on HOTS, preceded by scaffolding by the lecturer.

3.2. Discussions
To identify the stages of scaffolding by lecturers in developing mathematical creativity, the lecturer has carried out a series of activities as follows. Stage 1: Lecturer provides lecture material in accordance with the contents of the Lesson Plan (RPS), then give the Graph Theory problems as exercises and solutions to students. Students learn or practice solving problems based on instructions or examples from lecturer. Lecturer acts as resource person and facilitator. Stage 2: Lecturer starts giving examples of open ended mathematical problems based on HOTS through the method of discussion and question and answer, lecturer provides of solutions to students and then students learn or practice on their own to solve open ended mathematical problems based on HOTS or examples given by lecturer. Mathematical creativity began to be implanted in students' thinking. Lecturer is still the main resource person. Stage 3: Lecturer provides open ended mathematical problems based on
HOTS to students and then students learn or practice solving their own problems with instructions or guidance from the lecturer proportionally. Lecturer assistance is individual to students who need it. Mathematical creativity began to grow. Stage 4: The lecturer gives HOT open ended mathematical problems especially Graph Theory problems to the students and then the students solve or look for the open ended mathematical solutions without guidance from the lecturer. Students are trained to learn independently, so that mathematical creativity grows.

Until now, building creativity in students in universities still bad in attention, especially in learning of Discrete Mathematics. The lecturer does not try to increase the creativity of students in solving of problem variations because the problems given have only one right answer. The lecturer is not accustomed to teaching mathematical problems that have more than one correct answer or problems that have more than one solving algorithm.

According to [15] and [16], the growth of student creativity is closely related to the student's creative thinking process and is also closely related to students' ability to find various ways of finding solutions. Creating itself has the meaning of putting elements together to form a related and functional whole or rearranging elements into a new pattern. Building a process of mathematical creativity requires systematic, planned, and measurable action. Systematic means that every action taken must be functionally interrelated. Planned means the action of learning has been prepared and implemented with careful planning. Measured means that the learning action can be evaluated for success. The whole action is a combination of open ended thinking and creative thinking logic.

Furthermore, [17] also developed creative processes of mathematical thinking of students through mathematical problems that are problematic or open ended problems that are HOTS. In addition, [18] has used mathematical creativity competencies of students to be skilled in proving, have the ability to remember in their long-term memory, able to be innovative, and have good reasoning.

4. Conclusions
The conclusions are as follows. (1) The scaffolding stage is identified by the lecturer to foster Mathematical Creativity. (2) The results of analysis of fundamental thoughts are obtained to foster Mathematical Creativity of students through the provision of open ended problems based on HOTS.

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