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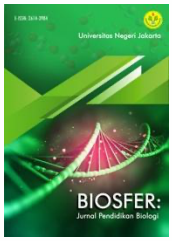

Creativity profile of biology teacher candidates: An exploratory study

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ABSTRACT

Creativity is one of the important skills that teachers must have today. Creativity can be defined as the human ability to generate new and valuable ideas. In addition, creativity is considered as a basic competency that needs to be possessed by students in higher education. The purpose of this study was to determine the creativity of prospective biology teachers and its relationship with students' knowledge mastery. For this purpose, a descriptive and correlational study was conducted on 13 biology pre-service students. The instrument used in this study was the Torrance creativity test based on 4 creativity indicators: fluency, flexibility, originality and elaboration. Descriptive and correlational analyses were conducted to identify students' creativity profiles and the relationship between students' creativity and their knowledge mastery. The results showed that there were three types of creativity owned by prospective biology teacher students, namely students with low (38.46%), medium (38.46%) and high (23, 07%) levels of creativity. The correlation test results show that concept mastery correlates with student creativity (r=0.3). The conclusion of this study is that prospective biology teacher students have different creativity, and there is a correlation between students' concept mastery and their creativity level so that there needs to be an effort from lecturers by designing learning strategies that can increase student creativity and concept mastery.

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INTRODUCTION

Creativity is is an essential basic skill for success in the future, so it is important for students, especially prospective teachers, to have this skill. (Gieras, 2019; Jaenudin, 2023). Teachers must be creative in order to create meaningful and enjoyable learning experiences. Learning activities need to be designed or designed in such a way as to help students have a number of abilities that are the outcomes of a learning process. Creativity plays an essential role in today's society and in improving the quality of education, as its development and the processes involved encourage higher-order types of learning (Mazeh, 2020; Purwati & Alberida, 2022)

Creativity is the human ability to generate new and valuable ideas, which involves a certain degree of originality and adaptation to specific situations (Kaufman & Sternberg, 2010). *Creativity* can be defined as the process of elaborating and validating hypotheses by considering sensitivity to problems, gaps, and information gaps that lead to the formulation of conjectures and hypotheses about problem solutions (Jang et al., 2021; Khotimah & Lestari, 2023). Creativity is a combinatorial process, i.e., the ability to connect learned knowledge to solve and discover problems and generate new ideas. Hence, it tends to be related to problem-solving, given that both aspects share many processes. Creativity is associated with the process of producing something different.

Most studies on creativity in university settings show creativity development, although unevenly. On the other hand, creativity development efforts still need to be improved, as universities' teaching and learning model tends to be monotonous and unchanging (Redhana, 2019; Setiono, 2021; Sutaphan & Yuenyong, 2023). Therefore, there are challenges related to the need to design learning strategies and educational processes that involve teachers in developing creative learning experiences that enable them to generate knowledge and respond to social, scientific, and technological problems (Ridwan et al., 2022).

Creativity can be influenced by many factors, including the knowledge students possess. Knowledge of biological content, for example, will affect students in solving biological problems creatively. The knowledge formed in students will facilitate the cognitive processes that occur in the brain; this will affect the creativity produced by students in solving problems (Jaenudin, 2023)

In teacher preparation education, creativity is considered one of the systemic competencies teachers must have (Departement of Education, 2004). *Creativity* is a combinatorial ability that must be supported by many factors, such as academic ability, psychological conditions, and external factors (Jaenudin, 2023). However, future teachers' creative thinking development must be sufficiently supported by educational professionals and didactic conditions to meet this challenge. The results of previous research indicate that teachers' skills, attitudes, role modeling, awareness of students' needs, flexible scheduling of learning activities, and specific types of classroom interactions are essential for teaching creativity (Mazeh, 2020). It is further suggested that for the formation of higher-order creative thinking in Higher Education, specific and deliberate learning experiences are required (Borodina et al., 2019). Learning experiences need to be designed with various considerations so that the activities carried out by students can train creativity. Research on creativity has been done a lot, but research that tries to assess creativity in prospective biology teacher students still needs to be made available. This study explores information related to the creativity profile of prospective biology teacher students and the correlation between creativity indicators and factors that influence the creativity of prospective biology teacher students

METHODS

The method in this study is a quantitative descriptive method with the aim of obtaining a description of the creativity of prospective biology teacher students and the relationship between creativity and student concept mastery. The study involved n=13 prospective biology teacher students who were in the 5th semester of the Biology Education Study Programme at Muhammadiyah Sukabumi University. The population and sample of the study consisted of 13 students who contracted STEM (Science Technology Enginering and Mathematic) courses. The instrument used was the Torrance creativity test (Cipta et al., n.d.) It is based on four indicators of creativity: fluency, flexibility, originality and elaboration. The instrument was designed to assess creativity in adults and adolescents, and also assess different aspects of creativity. The previously developed test was judged by 2 lecturers with expertise in biological learning evaluation. Before the test, students were given specific instructions on how to answer the creativity test. The test lasted for 50 minutes. After the test was completed, the copies

were collected and corrected for later analysis. Data on student concept mastery was obtained from the results of the student concept mastery test results of the midterm and final semester exams. This concept mastery test is in the form of a test of student mastery of the subject of STEM.

Statistical analysis was conducted on the creativity test data based on 4 creativity indicators: fluency, flexibility, originality and elaboration. The creativity test data was then analysed to determine the level of student creativity achievement whether at low, medium and high levels. The data on the results of creativity is also associated with students' mastery of concepts, to find out whether there is a relationship or not between students' mastery of concepts and the creativity shown by students. For statistical analysis, the SSPS-26 programme was used. The statistics used were descriptive statistics and Pearson correlation. Student creativity scores were categorised according to the creativity achievement categories in table 2. Then the student creativity scores were tested for correlation based on the correlated factors including student concept mastery and creativity indicators.

Table 1.
Criteria of Student' Creativity Skills Level

Percentage (%)	Criteria
<55	Low
≤55-<75	Medium
≥75	High

(Pratiwi et al., 2019)

Table 2.
The interpretation of the correlation coefficient is shown in the following table:

Correlation Coefficient (Positive or Negative)	Interpretation of Correlation Coefficient
0	No correlation between two variables
$0 < r \leq 0{,}25$	Very weak correlation
$0{,}25 < r \leq 0{,}5$	Moderate correlation
$0{,}5 < r \leq 0{,}75$	Strong correlation
$0{,}75 < r \leq 0{,}99$	Very strong correlation
1	Perfect correlation

(Sarwono, 2006)

A positive correlation coefficient indicates a unidirectional relationship, while a negative correlation coefficient indicates an opposite relationship.

RESULTS AND DISCUSSION

This study aims to get an overview of the creativity of prospective biology teachers and the relationship between creativity and mastery of the concept of prospective biology teachers. Data from the measurement of creativity and mastery of student concepts can be seen in Table 3. Data from the measurement of the creativity of prospective biology teacher students show that there are three types of creativity possessed by prospective biology teacher students, namely students with low (38.46%), medium (38.46%) and high (23, 07%) levels of creativity Figure 1. Figure 1 and 2 show that the creativity of prospective biology teacher students has different achievements, there are students with high, medium and low creativity.

Table 3.
Measurement Data of Student Creativity and Concept Mastery

	Creativity	Concept Mastery
Average	61,30	84,22
Max	76,88	91,74
Min	45,00	61,84
Modus	65,00	85,18
Median	65,00	85,18
SD	13,24	8,15

Table 1 shows the data from the measurement of student creativity and concept mastery. The data shows that the average score of students' concept mastery is higher than students' creativity.

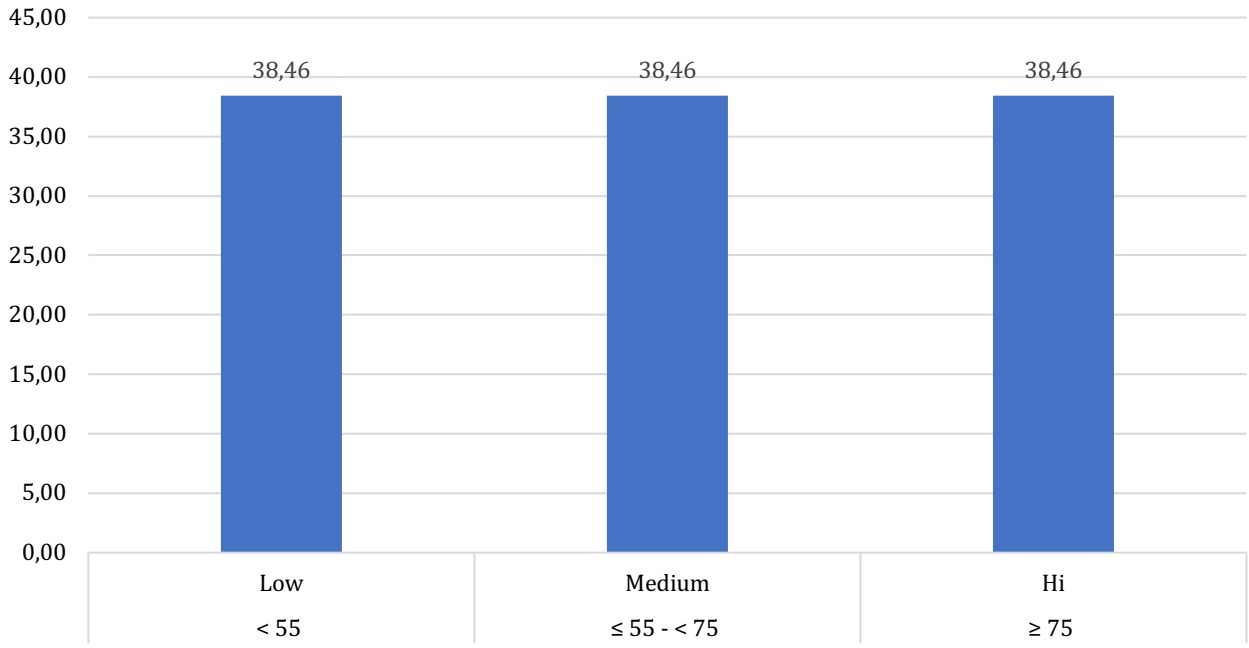
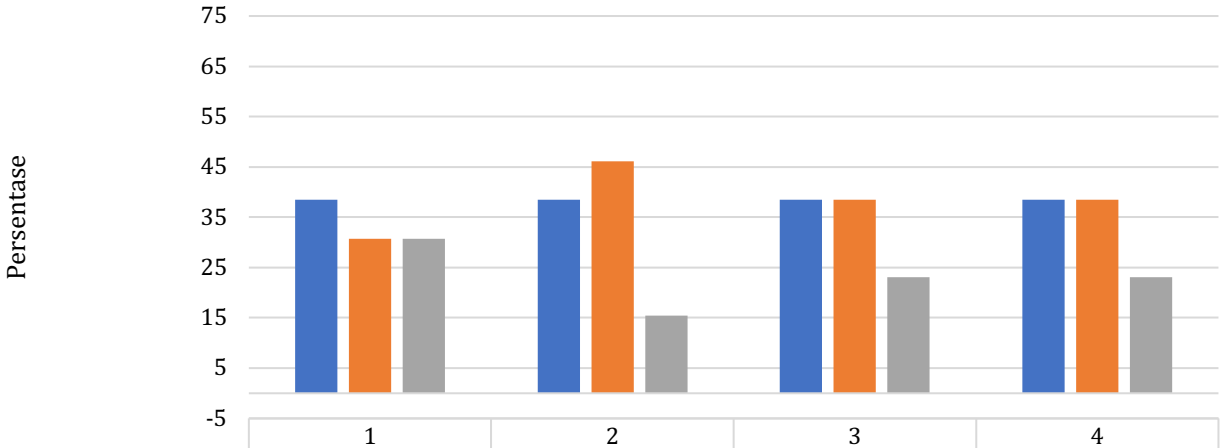


Figure 1. Percentage of Student Creativity Based on Low, Medium and High Creativity Categories

Figure 1 shows the creativity of biology teacher candidates who took STEM courses. The data shows that student creativity varies, there are students with high, medium and low creativity. However, most students already have medium and high creativity, this is certainly a basic asset for students to take lectures in other courses.



	1	2	3	4
< 55 Low	38,46153846	38,46153846	38,46153846	38,46153846
≤ 55 - < 75 Medium	30,76923077	46,15384615	38,46153846	38,46153846
≥ 75 Hi	30,76923077	15,38461538	23,07692308	23,07692308

Figure 2. Creativity Category of Biology Teacher Candidate Students. Description: (1) Fluency; (2) Fleksibility; (3) Originality; (4) Elaboration

Figure 2 shows student creativity in each creativity indicator, namely: : (1) Fluency; (2) Flexibility; (3) Originality; (4) Elaboration. Based on Figure 2, it is known that the number of students with high creativity criteria is still lower than the medium and low criteria, especially in the indicators of flexibility, originality and elaboration. Creativity is the result of a complex thinking process, so there are many influencing factors such as knowledge, thinking skills, motivation, environment and other factors. (Gieras, 2019; Jaenudin, 2023). Fluency requires students to generate ideas or ideas, Fluency requires students to think diferently or broadly. Most students can generate many ideas in problem solving. In the flexibility indicator, students are required to produce many ideas and have uniqueness,

in this indicator students still have difficulties. Students have difficulty generating ideas that are truly different or unique. Ideas or ideas generated by students in problem solving tend not to have uniqueness. This is also seen in the elaboration indicator. Indicators of flexibility and originality and elaboration require the ability to think diferently and think complexly (Kaufman & Sternberg, 2010; Nasution et al., 2023).

This condition is a challenge for lecturers to improve students with moderate and low creativity. This difference in creativity can be caused by many factors including: psychological strength, drive to innovate, and instrinsic motivation (Jaenudin, 2023; Othman & Jabari, 2012). Based on this, it is important for lecturers to design learning experiences that can positively influence the factors that influence student creativity (Madyani et al., 2020). Lecturers must design learning activities, determine methods, learning models, learning media and assessments that encourage student creativity. Creativity is an outcome of the learning process that emerges from a complex process that influences each other. Creativity emerges as a result of a combination of intellectual abilities, knowledge, mindset, it is important for lecturers to create learning experiences that contribute to the intellectual abilities, knowledge and mindset of students.(Gieras, 2019; Kaplan, 2019). Context in learning is also important. Creativity can emerge if the teacher presents the right context, a context that bridges the emergence of creativity. (Mazeh, 2020). Context can help connect existing knowledge with new knowledge or new problems. In addition, the context or situation that is close to the learners can increase students' motivation to learn the material widely and deeply, which will certainly encourage creativity.

Table 4.
Correlation between Concept Mastery and Creativity Indicators

		Concept Mastery	Creativity	Fluency	Fleksibility	Originality	Elaboration
Concept Mastery	Pearson Correlation	1	.303	.330	.261	.351	.244
	Sig. (2-tailed)		.315	.270	.388	.239	.422
Creativity	Pearson Correlation	.303	1	.993**	.991**	.996**	.980**
	Sig. (2-tailed)	.315		.000	.000	.000	.000
Fluency	Pearson Correlation	.330	.993**	1	.985**	.993**	.956**
	Sig. (2-tailed)	.270	.000		.000	.000	.000
Fleksibility	Pearson Correlation	.261	.991**	.985**	1	.984**	.962**
	Sig. (2-tailed)	.388	.000	.000		.000	.000
Originality	Pearson Correlation	.351	.996**	.993**	.984**	1	.967**
	Sig. (2-tailed)	.239	.000	.000	.000		.000
Elabo-ration	Pearson Correlation	.244	.980**	.956**	.962**	.967**	1
	Sig. (2-tailed)	.422	.000	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4 shows the correlation between mastery of biological concepts and creativity. The data shows that there is a correlation or relationship between mastery of biological concepts and creativity, the correlation coefficient between mastery of concepts and creativity: 0.303 this shows there is a correlation or relationship with a sufficient category. This shows that concept mastery is the basis for student creativity, this is reinforced by the data shown in Table 4 which shows that upper group students with high concept mastery ability have high creativity. The knowledge possessed by students can help students elaborate deeper information, this will encourage one's creativity (Mazeh, 2020). Creativity is not only determined by the knowledge possessed by students but there are many other factors that contribute to the emergence of student creativity.

Table 5.
Correlation of Concept Mastery and Creativity Indicators by Class Group (Upper, Middle and Lower Classes)

		Creativity	Fluency	Fleksibility	Originality	Elaboration
Concept Mastery	Combined class	.303	.330	.261	.351	.244
	Upper class	.895	.780	.787	.860	.951*
	Middle class	.079	.053	.053	.032	.156
	Lower class	-.664	-.767	-.767	-.585	-.597

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5 illustrates that students' mastery of knowledge is one of the factors determining whether or not students can bring out creativity. Knowledge is the basis for students to construct ideas or ideas to elaborate on ideas or ideas that arise. (Gieras, 2019; Jang et al., 2021; Munawaroh et al., 2018). Teachers as leaders in the learning process must pay attention to the characteristics and conditions of the teaching and learning process so as not to become an obstacle to the process of knowledge construction by students, and try to help students develop their creativity naturally in the classroom. It is necessary for students to have sufficient knowledge to showcase their creativity.

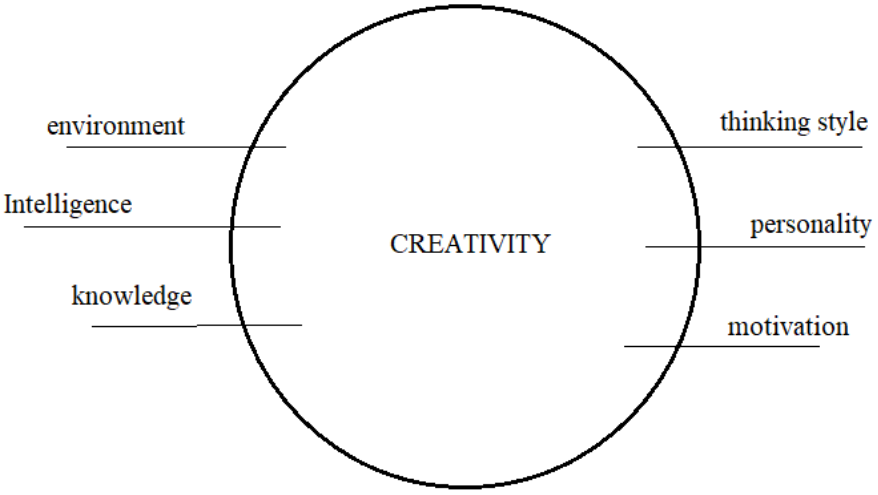


Figure 3: Aspects that Influence Creativity

Figure 3 shows that there are many aspects involved in the emergence of creativity in students. Lecturers must help students develop these behaviours by designing creative learning activities. So that the potential creativity of students can be trained and emerge as a competence.

This research was conducted on students who contracted STEM courses, previously students gained knowledge related to how to implement STEM learning models for students in high schools, the learning experience gained by students was only limited to theoretical learning experiences about the implementation of STEM learning. The learning experience gained by students with minimal practice is what causes many students to have low levels of creativity. The results of this study can be a recommendation for the implementation of STEM courses that previously lacked practice. Implementing STEM learning cannot only be done through theoretical learning experiences but must also be accompanied by practical experience doing STEM-based projects. (Kaufman & Sternberg, 2010). The STEM learning model has the potential to develop student creativity, because the STEM model provides opportunities for lecturers to manage classroom learning by involving students in project work. (Astuti et al., 2022; Biazus & Mahtari, 2022). Working on projects is a very challenging activity and leads students to design, solve problems, make decisions as well as carry out investigative activities. This activity will train students to come up with many unique ideas or ideas and elaborate on these ideas, so that it will contribute to student creativity. The project experience will be able to encourage learners to apply knowledge and skills and provide opportunities to expand knowledge through

problem solving and investigation. (Astuti et al., 2022; Biazus & Mahtari, 2022; Munawaroh et al., 2018; Pramashela et al., 2023; Usmeldi & Amini, 2022). In addition to the STEM model, lecturers can also apply other learning models such as inquiry, problem-based learning and other learning models that fully involve students in learning activities.

CONCLUSION

Based on the results of the study, the following conclusions can be drawn: 1) the creativity of prospective biology teachers can be categorised into students with high, medium and low creativity. 2) Students' concept mastery is correlated with students' creativity, so that students' concept mastery becomes an important factor that determines students' creativity. 3) Student creativity is influenced by many factors including: student personality, environment, thinking style, motivation, student knowledge and intelligence. Lecturers need to design activities or learning experiences that encourage student creativity.

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