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Relationship between level of scientific creativity and scientific attitudes among prospective chemistry teachers

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ABSTRACT

Scientific creativity and scientific attitude are important things that must be passed on in science learning. That is because the level of scientific creativity and scientific attitude could influence the performance in learning. As the same crucial components in learning, this research aimed to study the relationship between the level of scientific creativity and scientific attitudes. This study involved 92 prospective chemistry teachers in Pekanbaru, Indonesia who were selected using sample-simple random sampling. The data was collected through a chemistry scientific creativity test (CSCT) in form of open-ended questions, and a scientific attitude questionnaire. The data further was analyzed using SPSS 26.0 with a calculation of spearman correlation. The result showed that there was no relationship between the level of scientific creativity and scientific attitudes with Sig. 2-tailed=0.193, r_s=0.137. It indicated that the level of scientific attitude was not the dominant factor that could influence the level of scientific creativity among prospective chemistry teachers in this study. Thus, this finding could be a consideration for educational stakeholders to explore the dominant factor that affected scientific creativity.

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1. INTRODUCTION

Creativity is a common term in the educational system in this era because one of the demands of the 21st century is creativity. Creativity is the ability related to producing original ideas and items that also combine the existing work and objects in unique ways for the current goals [1]. In the field of science, creativity is known as scientific creativity [2]. Scientific creativity is the intellectual ability to provide original products and features of the non-public or social and is designed with a specific motive in mind using the knowledge provided [3]. Scientific creativity is a form of thinking style or trait, it emphasizes scientific knowledge, scientific inquiry skills, and creative thinking [4], [5]. It is an overview of an individual's thinking skills that can produce many original ideas from many fields to solve problems [6].

Countries in overall the world has emphasized creativity, either developed or developing countries consider creativity as a cognitive competency that educators must apply in learning and teaching activities such as in the United States, the United Kingdom, and Malaysia [7]–[9] Indonesia also has emphasized creativity in the curriculum (the 2013 curriculum) which requires learning, and teaching activities must emphasize 4C (creativity thinking, critical thinking, communication, and collaboration) and higher order thinking skills (HOTS), one of which is creativity [10]. As important components emphasized in the 2013 curriculum make the need for scientific creativity to be investigated and implemented. Teachers must have scientific creativity that will impact how they carry out learning in class so that it further will affect the students being taught.

Besides scientific creativity, attitude is also crucial in the 21st century era among the next generation [11]. In the science curriculum, scientific attitude is a term used in the educational field, and countries emphasize scientific attitude in their curriculum. For example, the curriculum in Pakistan emphasizes a scientific attitude in science curriculum [12]. Also, the Indonesian curriculum in the 2013 curriculum has emphasized the importance of assessing scientific attitudes in the classroom. In the 2013 curriculum, scientific attitude is also one of the competencies contained in the Indonesian curriculum. Students are required to be active in finding concepts or facts through observation, experimentation, and concluding data from the results obtained [13].

Through scientific attitude, it can produce students with good characteristics such as students with outstanding learning outcomes, and enhance students' scientific activity performance. Attitude is a set of reactions towards something based on someone's conceptual beliefs. In science, an attitude that involved someone directly and is related to the investigation or scientific activities is known as a scientific attitude. Scientific attitude is also defined as the way of viewing something, and curiosity to obtain information about how and why something can be happened factually [14]. It is an attitude possessed by academics or scientists when facing problems [15].

Many studies found the importance of a scientific attitude and it must be emphasized in learning science. In this case, a scientific attitude can produce good characteristics for the nation to be able to solve the problem encountered. In the field of education, students who had a good scientific attitude will remain inherent in everyday life [16]. Scientific attitude is an important aspect of learning science because it cannot be separated from scientific concept development [17]. Also, scientific attitude can influence students' learning outcomes and the most important outcomes of science teaching [18]. Considering scientific attitude in learning and teaching activities of science, supports and enhances the performance of students' scientific activity [19].

The teachers have an important role in supporting students' scientific attitude, the ability to carry out this role must also be owned by someone who will become a teacher so that later they can foster good learning outcomes in their students. It is supported by previous research [20] which stated that in the efforts to prepare prospective teachers who are competent in the field of science, it is necessary to first investigate the scientific attitude that science teacher candidates must have. This is because prospective teachers have to prepare in advance a positive attitude which later will become a role model for their students.

The scientific attitude is an important attitude that must be possessed by students, teachers, and also prospective teachers in science which is the same with scientific creativity. The importance of two skills in science makes the need of investigating whether both have a relationship with each other. Because both skills influence the performance of chemistry teachers in the classroom. Thus, it raises the question, does prospective chemistry teachers' scientific attitude influence their scientific creativity? Therefore, this study aims to study the relationship between the level of the prospective chemistry teachers' scientific creativity and scientific attitude.

2. RESEARCH METHOD

This study was a correlation study with a quantitative approach. This study aimed to investigate the relationship between the level of scientific creativity and scientific attitude. Thus, it was a way of investigating the relationships between variables, which were prospective chemistry teachers' scientific creativity and scientific attitude).

The population in this study was chemistry education students in their 4th year in the teacher chemistry education program in Pekanbaru, Riau, Indonesia. To determine the minimal sample size from the population, it was used simple size table by [21], population size in this study is 120, and based on Krejcie and Morgan's table, the sample size is 92. Furthermore, 92 chemistry students involved in this study were selected using sample-simple random sampling using a random generator.

To collect data, this study used one set of instruments including a chemistry scientific creativity test in form of open-ended questions which referred to Park's model with three components of scientific creativity (creative thinking, scientific knowledge, and scientific inquiry skills). Furthermore, scientific attitude questionnaires used were developed and have been validated by three experts. Elements of scientific creativity are curiosity, open-mindedness, objectivity, and a critical attitude. Both instruments are reliable with alpha Cronbach=0.636 (reliable) for the chemistry scientific creativity test and 0.866 (very reliable) for the scientific attitude questionnaire. To determine the level of scientific creativity, it was analyzed using the rubric of scoring and percentage of score to further be compared to level criteria as shown in Table 1.

Furthermore, the median was used to analyze the level of scientific attitude because in this study data used was ordinal with a scale of 5-point in the level of agreement has two positive responses, namely strongly agree=5, and agree=4, and two negative responses (strongly disagree=1 and disagree=2). The level of scientific attitude among the prospective chemistry teachers was determined from the overall median obtained which was interpreted as a level of agreement. If the result revealed positive responses, thus the level of scientific attitudes is at a high level, negative responses (low level), and if the overall median obtained was 3 (neutral), the level of prospective chemistry teachers is moderate.

Table 1. Criteria of scientific creativity level

Percentage of score	Level of scientific creativity
68–100	High
34–67.99	Moderate
0–33.99	Low

The result of the level of scientific creativity and scientific attitude was used to further analysis to investigate the relationship between the level of scientific creativity and scientific attitude. To investigate the relationship between the level of scientific creativity among prospective chemistry teachers and the level of scientific attitude, the researchers used the Spearman correlation. The Spearman correlation is used to measure the relationship between X and Y when the variables are ordinal scales [22]. The variables used in this study were the level of prospective chemistry teachers' scientific creativity and level of scientific attitude, where both are ordinal scales. The calculation of the Spearman correlation was analyzed by using SPSS version 26.0.

In general, if sig. value is less than α (0.05), H_0 must be rejected. Furthermore, to determine whether the Spearman correlation is statistically significant (i.e., H_0 must be rejected), it should refer to the critical values table of the spearman correlation. To be significant, the sample correlation r_s must be greater than or equal to the critical value in the table. The table is built on the concept that sample correlations must be representative of the corresponding population value. According to Schober and Schwarte [22], for n $\pm$ 90, the level of significance for the two-tailed test (0.05) r_s=0.207. Furthermore, if the result is significant, the correlation coefficient can be used to interpret the strength of the relationship as shown in Table 2 [23].

Table 2. Interpretation of correlation coefficient

The absolute magnitude of the observed correlation coefficient	Interpretation
0.00-0.10	Negligible correlation
0.10-0.39	Weak correlation
0.40-0.69	Moderate correlation
0.70 0.89	Strong correlation
0.90-1.00	Very strong correlation

3. RESULTS AND DISCUSSION

Scientific creativity and scientific attitude are two components that must be had by chemistry teachers. It is caused by how their level of scientific creativity and scientific attitude will influence prospective chemistry teachers' performance in their classroom. Before investigating the relationship between scientific creativity and scientific attitudes, the level of scientific creativity and scientific attitude is found in Table 3.

Table 3. Level of scientific creativity and scientific attitude

Scientific components	Elements	Result	Level	Overall
Scientific creativity	Fluency	Percentage of score=27.42	Low	Percentage of score=35.43
	Flexibility	Percentage of score=27.29	Low	(Moderate)
	Originality	Percentage of score=51.57	Moderate	
Scientific attitude	Curiosity	Median=4	High	Median=4 (High)
	Open-mindedness	Median=5	High	
	Objectivity	Median=5	High	
	Critical attitude	Median=4	High	

Based on Table 3, the prospective chemistry teachers' level of scientific creativity is moderate with a percentage score of 35.43. The result shows that the prospective chemistry teachers are lacking scientific creativity especially creative thinking with fluency (percentage score=27.42) and flexibility (percentage score=27.29), and a moderate level of originality (percentage score=51.57). A moderate level of scientific creativity is caused by low fluency and flexibility in producing ideas among prospective chemistry teachers. A low level of fluency and flexibility indicates that prospective chemistry teachers are low in producing ideas that affect their scientific creativity.

On the other side, the level of scientific attitude among prospective chemistry teachers is high with a median of 4, which means the prospective chemistry teachers agree with statements provided that show their scientific attitude such as curiosity, critical attitude, open-mindedness, and objectivity is also high. The highest elements of scientific attitude are objectivity and critical attitude with a median of 5, and the lowest elements

are curiosity and critical attitude with a median of 4. Overall, the level of scientific attitude among prospective chemistry teachers is high. The high level indicates that the prospective chemistry teachers have no problem with scientific attitudes. Furthermore, to study the relationship between two of those variables, the Spearman correlation was used, and based on the result of the SPSS analysis, the result showed in Table 4.

Table 4. Spearman correlation analysis results

n	Sig. (2-tailed)	Spearman's rho (Correlation coefficient)
92	0.193	0.137

Based on Table 4, it shows that Sig. (2-tailed) is 0.193 which is greater than 0.05 ($p>0.05$), which indicates that this study fails to reject H_1. It also is confirmed by Spearman's rho obtained namely r_s (0.137) which is less than the critical value ($r_s=0.207$) for $n \pm 90$, with the level of significance for the two-tailed test (0.05). Thus, it can be concluded that H_1 is rejected and H_0 is accepted. It means that there is no statistically significant relationship between the level of scientific creativity and the level of scientific attitude.

This finding is similar to previous research [24] which also found that there was no significant relationship between student's scientific attitude and students' scientific creativity levels ($r=0.052$, $p>.05$). The absence of an insignificant relationship between scientific creativity and scientific attitude also can be seen from the relationship between the dimension of scientific creativity (creative thinking) and scientific attitude. In this study, creative thinking was defined as divergent thinking because it had a significant positive correlation with scientific creativity [25]–[28]. The creative thinking skill level of prospective chemistry teachers in this study is at a low level for fluency and flexibility, and a moderate level for originality, whereas the level of scientific attitude among the prospective chemistry teachers is at a high level. It indicates that a high level of scientific attitude does not guarantee high creative thinking. This study found that the prospective chemistry teachers have a high level of scientific attitude toward all elements (curiosity, critical attitude, open-mindedness, and objectivity). It means that the prospective chemistry teachers' scientific attitude has been well formed. However, the prospective chemistry teachers' creative thinking has been not yet well formed. It is supported by [14] also found that there was no significant relation between scientific attitude and creative thinking skill in chemistry with sig. value=0.646. This is because the development of an individual's creative thinking is determined by many other variable factors so scientific attitudes do not contribute to creative thinking skills [29].

The finding in this study contradicts previous research [13], who found that there was a significant effect of scientific attitude on scientific creativity. Although there is a study that found that scientific attitude affects scientific creativity, however, the prospective chemistry teachers' level of scientific attitude in this study did not influence their level of scientific creativity. It means that scientific attitude is not the dominant factor affecting the scientific creativity level in this study. That is because scientific attitude is not the only factor that affected scientific creativity. There are many factors affecting scientific creativity such as lacking teaching about scientific creativity which aims to help students understand how science researchers work creatively to develop new theories, less effort in developing scientific creativity [30], cognitive achievement [31]–[33], thinking and inquiry skills [29], and involvement of parents and teachers, as well as the school climate [34].

4. CONCLUSION

The result shows that there is no significant relationship between the level of scientific creativity and the level of scientific attitude (Sig. 2-tailed=0.193, $r_s=0.137$, $n=92$). This finding shows that even though the scientific attitude of the prospective chemistry teachers has formed well, it did not guarantee their scientific creativity. Thus, it can be concluded that scientific attitude is not a factor dominant to determine scientific creativity. However, due to the small sample size, the findings are only applicable to prospective chemistry teachers in this study so the result cannot be generalized.

Furthermore, no relationship between the level of scientific creativity and the level of scientific attitude adds insight to educational stakeholders that a high scientific attitude does not guarantee high scientific creativity skills. In addition, this finding also helps to provide information to lecturers that instead of instilling a scientific attitude among students, scientific creativity also needs to be trained because these two things are not always interconnected. Therefore, the evaluation in the lecture process must be improved, not only based on academic achievement, and scientific attitude, but also must begin to consider the scientific creativity of students since the level of scientific creativity among prospective teachers is still moderate.

This study is limited to identifying scientific creativity by using scientific knowledge related to chemistry, especially on the topic of the rate of a chemical reaction. In addition, the scientific inquiry skills involved are only predicting, interpreting data, and designing experiments so there are gaps to explore scientific creativity using other skills. Furthermore, this study found that scientific attitude was not the dominant factor in influencing the level of scientific creativity. Therefore, the researcher recommends future research to identify other elements of scientific attitudes and other components that may affect scientific creativity among prospective chemistry teachers.

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