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Perspectives of Science Teacher Candidates Regarding Scientific Creativity, And Their Ability to Reflect Scientific Creativity in Their Education

Dr. Sibel Demir (Corresponding author)
Ondokuz Mayıs University, Science Teaching Department, Samsun/Turkey

Abstract
This study was performed with the participation of 20 teacher candidates from the science education department of a university in Turkey. During the study, teacher candidates were asked two questions, both of which were open-ended. The validity of these questions developed specifically for this study was evaluated by two expert researchers. The aim of this study was to determine how science teacher candidates define scientific creativity, and how they are able to reflect scientific creativity on their own education. The study results indicated that the science teacher candidates lacked an in-depth understanding or interpretation of this concept, and that their ability to reflect scientific creativity in their own education was limited.
Key Words: Teacher candidates, science education, scientific creativity, originality

Introduction

Creativity and scientific creativity are two higher thinking skills that support one another. In present-day societies, the products of creativity represent an essential human requirement. Unlike general creativity, scientific creativity is strongly associated with scientific knowledge, scientific skills, and scientific attitudes (Jo, 2009). In activities focusing on scientific creativity, it is important to gain a good understanding of the role played by knowledge in scientific creativity (Liang, 2002). Park (2011) describes that scientific creativity consists of three dimensions, which are creative thinking, scientific knowledge, and scientific inquiry. In their studies, Demir (2014) and Demir and Şahin (2014a, 2014b) described that possessing knowledge on a particular field is important for scientific creativity. Hu and Adey (2002), on the other hand, developed a "scientific creativity model" for field-specific creativity. This model consists of the following dimensions: fluency, flexibility, originality, imagination, thinking, scientific knowledge, scientific problem, scientific fact and technical product. When discussing scientific creativity, "*fluency can be defined as the collection of all ideas that are scientifically correct; flexibility can be defined as fluent thoughts formed in different areas and with different approaches; and originality can be defined as fluent ideas that are present at a certain percentage/ratio within the relevant group*" (Demir, 2014).

Teacher training is an important condition that should be addressed. A teacher can leave a mark on the development and raising of thousands of children. Teachers who can think creatively, see events from different perspectives, and project these perspectives can leave even deeper marks on the children they instruct. For this reason, we believe that it is particularly important to evaluate and determine the scientific creativity of teacher candidates.

In this context, the aim of this study was to determine how science teacher candidates define scientific creativity, and how they are able to reflect scientific creativity on their own education.

Methods

This study was performed with 20 science teacher candidates enrolled in the science education department of a university in Turkey. In this study, the science teacher candidates were asked two open-ended questions, which were, "*What does the concept of scientific creativity mean for you?*" and, "*As a teacher, what would you do to develop the scientific creativity of your students?*" Qualitative data obtained with the open-ended questions were classified according to predefined codes and themes, and the data were interpreted based on the number of times the codes were repeated. The validity of these questions developed for this study was evaluated by two expert researchers.

Results

Data obtained in this study were organized and presented in tables. Table 1 and Table 2 show the frequency of themes and codes identified in the qualitative data obtained from the teacher candidates.

Table 1. Themes and codes regarding the definitions of scientific creativity provided by the teacher candidates

Scientific Creativity Themes	Codes	N
Originality	Originality	3
	Difference/innovation	7
Scientific Knowledge	Science/Scientific Thinking	10
	Scientific knowledge	2
	Knowledge	1
Flexibility	In-depth/detailed examination	1
	Making associations with other ideas	0
Fluency	Producing numerous ideas	0
	Producing ideas/thoughts	5
Product	Making inventions	0
	Designing	3
	Products	3
	Performing experiments	0
Imagination	Imagination	2

As shown in Table 1, the science teacher candidates used various different terms to describe the concept of scientific creativity. Based on the frequency of these terms, it is was determined that the terms “science/scientific thinking,” “difference/innovation,” and “producing ideas/thoughts,” were the most frequently used; that the terms “making associations with other ideas,” “making inventions,” and “performing experiments” were not used at all; and that the terms “originality,” “scientific knowledge,” “knowledge,” “in-depth/detailed examination,” “designing,” “product,” and “imagination” were seldom used.

Table 2. Responses of the teacher candidates regarding the approaches they would use to develop the scientific creativity of their students

Codes	N
Making associations with daily life	2
Making associations with nature	4
Performing laboratory applications/experiments	6
Perform tours/visits	3
Ensure participation to scientific conferences	2
Avoid rote memorization	2
Encourage reading	4
Encourage research	3
Encourage designing	4
Promote imagination	2

As shown in Table 2, the expressions most frequently mentioned by the science teacher candidates regarding the approaches they would use, as teachers, to develop the scientific creativity of their students were “performing laboratory applications/experiments,” “making associations with nature,” “encourage reading,” “encourage designing,” “encourage research,” and “performed tours/visits.”

Conclusion and Discussion

Scientific creativity can be defined as the use of scientific perspectives to solve daily problems and meet everyday requirements (Demir, 2014). In this study, the perspectives of science teacher candidates regarding the concept of scientific creativity was evaluated according to various dimensions, which were the fluency, flexibility, originality, scientific knowledge, imagination, and product dimensions. Evaluation of the study results revealed that the most commonly used terms by the participating teacher candidates were “science/scientific thinking,” “difference/innovation,” and “producing ideas/thoughts;” while the terms “making associations with other ideas,” producing numerous ideas,” “making inventions,” and “performing experiments” were not used at all; and the terms “originality,” “scientific knowledge,” “knowledge,” “in-depth/detailed examination,” “designing,” “product,” and “imagination” were seldom used. This reveals that the science teacher candidates tended to perceive the concept of scientific creativity in a superficial way, and that they were not very familiar with actual meaning of this concept.

Based on the study results, it was also determined that the science teacher candidates most commonly mentioned the following expressions/terms when describing the approach they would use to develop the scientific creativity of their students: “performing laboratory applications/experiments,” “making associations with nature,”

"encourage reading," "encourage designing," "encourage research," and "performed tours/visits."
The study results indicated that the science teacher candidates lacked an in-depth understanding or interpretation of this concept, and that their ability to reflect scientific creativity to education was limited. Studies on creativity and science education indicate that activities for developing creative thinking, as well as the techniques associated with these activities, are quite effective in developing creativity (Orçan, 2013). Findings of studies from around the world similarly illustrate that suitable and effective educational environments, materials and teaching methods can positively contribute to the development of creativity among students (Orhon, 2011). It is generally believed that science classes assist the development of scientific creativity, and that placing further emphasis on creativity in these classes would better prepare students for the future (Kind and Kind, 2007). We believe that it is important to determine the level of scientific creativity of science teacher candidates, since these candidates will potentially have an important influence on future generations. In this context, we believe that it is necessary to conduct further studies aiming to assess and improve the scientific creativity of science teacher candidates.

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