A Study on the Evaluation of Scientific Creativity among Science Teacher Candidates

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Abstract

This study was performed with the participation of 31 science teacher candidates in their second year of higher education, enrolled in the science education department of a university in Turkey. During the study, the teacher candidates were asked two questions, one of which was a self-evaluation question regarding scientific creativity, while the other was an open-ended question. The validity of these questions developed specifically for this study was evaluated by two expert researchers. The aim of the study was to determine how science teacher candidates viewed scientific creativity, and how they evaluated/assessed themselves with respect to scientific creativity. The results of this study indicated that the science teacher candidates lacked an adequate understanding of the flexibility and originality dimensions of scientific creativity, and that they considered themselves as somewhat insufficient in terms of scientific creativity.

Key words: science teacher candidate, scientific creativity, originality, fluency, flexibility, scientific knowledge

Introduction

Creativity consists of at least four components, which are the creative process, creative product, creative individuals, and the creative situation (MacKinnon, 1970; Mooney, 1963; as cited by Lin, Hu, Adey, and Shen, 2003). Scientific creativity is a higher skill that has a significant effect on the innovative approach. In contrast to general creativity, scientific creativity is strongly associated with scientific knowledge, scientific skills, and scientific attitudes (Jo, 2009). Problem-solving, forming hypotheses, designing experiments, and technical innovation all require a certain form of scientific creativity (Lin, Hu, Adey, and Shen, 2003). Zhang, Liu, and Lin (2012), on the other hand, described that although scientific creativity requires various personal characteristics such as inner motivation, independence and initiative, these characteristics are sufficient by themselves in supporting scientific creativity. Hu and Adey (2002) previously developed a "scientific creativity model" for field-specific creativity, which consists of the following dimensions: fluency, flexibility, originality, imagination, thinking, scientific knowledge, scientific problem, scientific fact, and technical product. Within the frame of 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).

Creative thinking plays a complementary role in the scientific processes used during science- and technology-related studies (Akçam, 2007). The limiting factors of the long-term development of scientific creativity is the experience, knowledge, skills, and abilities of science teachers, and the quality of the developmental and educational opportunities that are provided to the students (Schmidt, 2010). In the current age of innovation, scientific creativity among science teachers is very important for ensuring the cultivation of this creativity skill in future generations. For this reason, we believe that it is particularly important to determine how teacher candidates see scientific creativity, and how they assess their own scientific creativity.

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Methods

This study was performed with 31 science teacher candidates in their second year of higher education, enrolled in the science education department of a university in Turkey. In this study, the 31 science teacher candidates were asked a multiple-choice question, with five possible answers, which was, "How would you rate your own level of scientific creativity?" Twenty one randomly selected science teacher candidates were then asked the following open-ended question: "Imagine that you a special power that only you possess. How would like to use this special power to advance the field of science?" 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 classifies the qualitative data (i.e. answers and expressions) obtained from the science teacher candidates with the open-ended question according to the four dimensions of scientific creativity, which are fluency, flexibility, originality, and scientific knowledge. Table 2 shows the codes identified in the teacher candidate responses to the open-ended question, while Table 3 and Table 4 show an example of two answers that were considered to illustrate flexibility and originality. Table 5, on the other hand, shows the teacher candidates' self-evaluation of their scientific creativity.

Table 1. Evaluation of the answers to the open-ended question according to the four dimensions of scientific creativity

Fluency	Scientific Knowledge	Flexibility	Originality
27	25	2	4

Table 1 shows that 27 of the answers provided by the teacher candidate reflected fluency, while 25 of these answers reflected scientific knowledge. Only two of the answers mentioned flexibility, and only four mentioned originality.

Table 2. The codes of the answers given to the open-ended question

Codes	N
Find cure for illnesses	4
Space/Planets	6
Establish a laboratory	2
Establish a science center	2
Prevent environmental pollution	3
Others	1 (by each teacher candidate)

Table 2 shows that the answers provided by the teacher candidates to the open-ended question particularly included views about seeing or making discoveries about space and other planets, finding cures for illnesses, and to prevent environmental pollution. It was observed that each teacher candidate provided at least one answer/opinion to the open-ended question asking them how they would like to advance science.

Table 3. Example of an answer to the open-question illustrating the flexibility dimension

Teacher candidate number 17: *"…..I would like to give people the ability to perform photosynthesis."*

The example in Table 3 shows that, by thinking about merging the characteristics of humans and plants, the teacher candidate was able to associate two different disciplines.

Table 4. Example of an answer to the open-question illustrating the originality dimension

Teacher candidate number 12: *"…such as giving people the ability to travel in their own brain …."*

Table 4 shows an example of the answers provided by the teacher candidates that reflect originality.

Table 5. The teacher candidates' self-evaluation of their own scientific creativity.

Fairly Adequate	Adequate	Partially Adequate	Inadequate	Fairly Inadequate	No Answer
0	6	17	7	0	1

As shown in Table 5, when asked to self-evaluate their scientific creativity, the science teacher candidates generally described themselves as having a partially adequate level of scientific creativity.

Conclusion and Discussion

As the number of scientific studies increases, so does the amount of accumulated scientific knowledge. Science education tends to place more emphasis on the learning scientific knowledge; however, it is more important to teach scientific methods as a set of skills rather than a form of knowledge (Gürdal, Şahin, and Çağlar, 2001). Scientific creativity plays an important role in this context. Scientific creativity can be described as a thinking skill that enables individuals to produce may original ideas in different areas by utilizing an interdisciplinary and innovative approach in science, technology, and arts (esthetics), generally with the aim of resolving a particular problem (Demir, 2014).

Based on the study results and the answers of the science teacher candidates, it was determined that their level of fluency and scientific knowledge was adequate, while their level of flexibility and originality was very low. In addition, the teacher candidates generally considered themselves as being partially adequate in terms of scientific creativity.

Science classes assist the development of scientific creativity, and placing further emphasis on creativity during these classes would allow students to be better prepared for the future (Kind and Kind, 2007). To ensure the development of scientific creativity, it is necessary to form rich learning environments through effective planning and by making use of different learning approaches, methods and techniques; promoting scientific creativity also requires effective planning, structuring, and organization of all learning processes, including the training and guidance of teachers/instructors (Demir, 2014). For this reason, we believe that it is important to evaluate and determine the scientific creativity of science teacher candidates. 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.

References

Akçam, M. (2007). *İlköğretim fen bilgisi derslerinde yaratıcı etkinliklerin öğrencilerin tutum ve başarılarına etkisi.* Yayınlanmamış yüksek lisans tezi, Balıkesir Üniversitesi, Fen Bilimleri Enstitüsü, Balıkesir.

Demir, S. (2014). *Bilimsel tartışma ve araştırmaya dayalı tasarlanan laboratuvar programının, fen bilgisi öğretmen adaylarının bilimsel yaratıcılıklarına etkisi.* Yayınlanmamış doktora tezi, Marmara Üniversitesi, Eğitim Bilimleri Enstitüsü, İstanbul.

Gürdal, A., Şahin, F., & Çağlar, A. (2001). *Fen eğitimi ilkeler, stratejiler ve yöntemler.* İstanbul: Marmara Üniversitesi Atatürk Eğitim Fakültesi Yayın.

Hu, W., & Adey, P. (2002). A scientific creativity test for secondary school students. *International Journal of Science Education, 24(4),* 389-403.

Jo, S. M. (2009). *A study of Korean students' creativity in science using structural equation modeling.* Unpublished doctoral dissertation, The University of Arizona.

Kind, P., & Kind, V. (2007). Creativity in science education: Perspectives and challenges for developing school science. *Studies in Science Education*, *43(1),* 1-37.

Lin, C., Hu, W., Adey, P., & Shen, J. (2003). The influence of case on scientific creativity. *Research in Science Education*, *33*, 143-162.

Schmidt, A. (2010). The battle for creativity: Frontiers in science and science education. *Insights & Perspectives*, 1016-1019.

Zhang, J., Liu, G., & Lin, C. (2012). An action-oriented approach to gifted education: Evidence from the field of scientific creativity. *High Ability Studies*, *23(1),* 123-125.