Research on Humanities and Social Sciences
ISSN (Paper)2224-5766 ISSN (Online)2225-0484 (Online)
Vol.5, No.17, 2015

Pre-Servıce Scıence Teachers' Self-Assessments of Scıentıfıc Creatıvıty and Proposals for Scıentıfıc Creatıvıty Actıvıtıes

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Abstract
This study was conducted with the participation of 21 pre-service science teachers attending the second year of a university in Turkey. Participating pre-service science teachers were asked a five-choice question on their self-assessments of scientific creativity, and an open-ended question on what they would do, as teachers, to improve the scientific creativity of their students. This study examines the pre-service science teachers' self-assessments of scientific creativity and proposals for scientific creativity activities. The data collected shows that pre-service science teachers have a preference for using laboratory/conducting experiments, connecting with daily life, and 'teaching by doing and living' to improve their students' scientific creativity skills, whereas activities such as having students prepare projects and conduct research are not very popular. A parallel finding was that most pre-service science teachers evaluate their scientific creativity skills as only partially satisfactory.
Keywords: scientific creativity, creativity activities, science education, pre-service teachers

Introduction

In contemporary society, science is considered to be a process that includes multiple truths, including the views of scientists, rather than being the only source of all truth (Önen, 2011). As a result, views about science have also changed, undergoing a significant transformation. New technologies have the potential to influence approaches to creativity and innovative design, and these cultural and technological transformations are reflected in the relationship between digital media, technology, and innovation (IJDCI, 2013). Creativity and innovation are effective teaching methods that create constructive learning environments, which are necessary for students to practice their cognitive processing skills, to integrate their previous knowledge with new information, and to actively participate in class activities (Wyke, 2013).

Vygotsky, expressly in his book titled "Imagination and Creativity in Childhood", developed a theory of creativity; underlining the role played by the relationship between imagination, emotions and thoughts in the creative processes of the human mind, investigating the relationship between reality and imagination in generating creativity, showing that human activities require both (Lindqvist, 2003). According to Maslow, on the other hand, creativity is related to the self-realization potential of an individual (Hanley and Abell, 2002). Another definition of creativity provided by Pelfrey (2011), describes creativity as a method that offers opportunities for students to make choices, to inquire, to discover themselves, to acquire multiple points of view, and to use their imagination to create innovative products. Neurobiological, psychological, and cultural studies, on the other hand, usually view creativity as a dialectical process between construction and de-construction, and between order and chaos (Holm-Hadulla, 2013).

In cognitive processes, field-specific knowledge and field specificity are important factors; to be able to come up with new ideas, people have to make use of the accumulated knowledge within a discipline (Liang, 2002). Scientific creativity always requires adding to the accumulated knowledge to create a new product (Liang, 2002). To use Hu and Adey's scientific creativity model, which they developed in 2002, ideas created by the imagination and rich thinking made possible by the integration of the disciplines of science, art, and technology, are improved by using the dimensions of flexibility and originality, and turned into products in the form of knowledge, problems, phenomena and production (e.g. literary, visual, experimental, etc.) (Demir, 2014a).

For children to be able to develop a contemporary, productive and creative world view, which future generations would arguably need in larger quantities than currently required, it is necessary for them to receive a high-quality education. In turn, the most important role in this process is played by teachers (Demir, 2014b). Therefore, it is particularly crucial that pre-service science teachers are given creativity training, and their current levels of creativity are investigated. Thus, this study aims to examine pre-service science teachers' self-assessments of creativity and their proposals for creativity activities.

Methodology

The study was conducted with the participation of 32 pre-service teachers attending the second year of the faculty of education of a in Turkish University. The participating pre-service science teachers were asked two questions, the validity of which was established by the two researchers. One of these questions was a five-choice self-assessment question on how the pre-service teachers evaluate their scientific creativity. The other question was an open-ended question on what the pre-service teachers would do to help improve their students' scientific creativity. Answers to the first question were analyzed by examining frequency distributions, and answers to the

second question were analyzed by coding them into content categories.

Results

Findings of the study are reported in Table 1 and Table 2. Table 1 reports the frequency distributions of the answers to the question on self-assessment of creativity, and Table 2 shows the answers to the question on activities to be done to improve students' creativity, coded into content categories.

Table 1. Data on self-assessed creativity

Very satisfactory	Satisfactory	Partially satisfactory	Unsatisfactory	Very unsatisfactory
0	5	10	6	0

As Table 1 shows, most pre-service science teachers describe their scientific creativity skills as only partially satisfactory.

Table 2. Activities to improve scientific creativity

Codes	N
Laboratory/Conducting experiments	7
Connecting with daily life	4
Teaching by doing and by living	4
Having the students prepare projects	2
Avoiding rote learning	2
Helping students understand nature	2
Having students conduct research	2
Use of visuals	2
Having students read about scientists	2
Taking students to scientific conferences	2
Other (total)	14

As Table 2 shows, pre-service science teachers prefer laboratory/conducting experiments, connecting with daily life, and teaching 'by doing and by living' in order to develop their students' scientific creativity skills. In addition, having students prepare projects, having students conduct research, helping students understand nature, the use of visuals, having students read about scientists and taking students to scientific conferences are also proposed, but by fewer pre-service teachers.

Conclusion and Discussion

All approaches to innovation take a creative idea as their starting point (El Bassiti and Ajhoun, 2013). In information societies, education is expected to create a 'new society', not to reproduce the existing one (Baykal, 2003). Innovation is consistent with the 'benefit' and 'use' qualities of creativity. At least theoretically, innovation is expected to solve some problem (such as the lack of a product in the market) (Villalba, 2008). Creativity and creative thinking, even though they are separate concepts, are sometimes used interchangeably. Creative thinking refers more to cognitive activities, whereas creativity involves both cognitive and performance related activities. Thus, creativity is a wider concept that also involves creative thinking (Aydın, 2006; Doğan, 2005).

In developing creativity, Fisher (2013) underlines the importance of teaching children that the process of problem solving is more important than the end results. Hands-on experiments, problem solving, class discussions, and cooperative work offer great opportunities to develop creative thinking and creative behavior (Kar, 2015). According to Meyer and Lederman (2013), the knowledge, experience and perceptions of the student; class and activity qualities; the attitudes and behaviors of the teacher; and the fluency, flexibility, and originality dimensions of scientific creativity all play a role in this process. The opportunity to grow into creative scientists should be offered to students at an early age (Cremin, Glauert, Craft, Compton & Stylianidou, 2015). Teachers should use productive methods in order to develop the creative potential of their students Lopatina, Borisov, Leyfa, Galimzyanova, Yatsevich, Demyanenko & Masalimova, 2015). This study found that pre-service science teachers propose to use laboratory/conducting experiments, connecting with daily life, and teaching 'by doing and by living' in order to develop their students' scientific creativity skills. However, they had a difficult time coming up with other activity examples. Parallel to this finding, it was also observed that most pre-service teachers evaluated their scientific creativity skills as only partially satisfactory. In order to encourage and facilitate scientific creativity in the classroom, views of science teachers should be taken into consideration (Liu and Lin, 2014). The development of creative and innovative skills has a central place in education, as these skills help develop a strong tie between knowledge and learning, and innovative teaching is necessary to achieve creative learning (Ferrari, Cachia and Punie, 2009). Creativity is found in every individual; it only needs to be supported and improved (Turla, 2003). Therefore, to be able to educate the innovative

generation, it is crucial that pre-service science teachers' scientific creativity skills are examined and improved.

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