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Pre-Servıce Scıence Teachers' Self-Assessments of Creatıvıty and Defınıtıons of Scıentıfic Creatıvıty

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Abstract
This study is based upon a self-assessment scale completed by 36 pre-service science teachers attending the faculty of education of a university in Turkey, and their replies to an open-ended question asked to 24 of them who were randomly selected. Pre-service science teachers were asked to complete a "Self-assessment of creativity" self report and asked an open-ended question on how to define scientific creativity. The study aims to examine pre-service science teachers' self-assessments of creativity and definitions of scientific creativity.
Keywords: creativity, scientific creativity, pre-service science teachers

Introduction

Creative thinking requires reaching a new, original synthesis by establishing links between seemingly unrelated concepts. In this process, analogical thinking, which is defined as establishing links between what is already known (source or analog) and new information (target), plays an active role (Kadayıfçı, 2008). According to Maslow, creativity is related to the ability of an individual to express themselves (Hanley and Abell, 2002), and Sasser (2006) thinks of creativity, innovation and integration as parts of the same whole.

Vygotsky considers the creative process in the human mind to be a crucial process, as well as the relationship between imagination, feeling and thinking, and argues that in creative thinking, the connection between reality and imagination is questioned, and human activity involves both (Lindqvist, 2003). Scientific creativity involves the process of the creation of original and useful ideas or products, in order to solve a problem or meet a need (Kanlı, 2014). Problem solving, hypothesis formation, designing experiments and technical innovation all require some form of scientific creativity (Lin, Hu, Adey and Shen, 2003). Hu and Adey (2002), argue that a specific test for scientific creativity is needed in addition to tests on general creativity, and developed the field-specific "scientific creativity model".

Science education should lead students to discover the value of high-level cognitive skills, and to learn creative problem solving. However, this does not necessarily mean that creative thinking skills are actually used in solving scientific problems, or even that those skills are well known (DeHaan, 2009). This observation calls attention to the importance of creative thinking and creative scientific thinking skills in science education, which in turn means that pre-service science teachers should become awarene of these high-level cognitive skills during their training. This is the reason why this study aims to examine pre-service science teachers' self-assessments of creativity and definitions of scientific creativity.

Methodology

This study was conducted using a self assessment scale completed by 36 pre-service science teachers attending the second year of the faculty of education of a university in Turkey, and asking an open-ended question to 24 of them who were randomly selected. The participants were asked to complete a "Self-assessment of creativity scale". The "How creative are you?" test, developed by Raudsepp, was adapted to Turkish by Sungur (1997). Later, Gülel (2006) had the test examined by linguists for fluency in terms of Turkish language and literature, and found the Cronbach's alpha reliability coefficient to be 0.761. In addition, pre-service science teachers were asked an open-ended question on how to define scientific creativity.

Results

Findings of the study are reported in Table 1 and Table 2. Table 1 reports percentage values of the individual items of the scale, whereas Table 2 reports the frequency of the themes and codes extracted from the definitions provided.

Table 1. Data on self-assessment of creativity scale

Items of the scale	Strongly disagree	Disagree	In between or don't know	Agree	Strongly agree
S1.It would be a waste of time for me to ask questions if I had no hope of obtaining answers.	50,0	25,0	8,3	8,3	8,3
S2. I occasionally voice opinions in groups that seem to turn some people off.	11,1	30,6	27,8	16,7	13,9
S3. I feel that I may have a special contribution to give to the world.	5,6	16,7	19,4	38,9	19,4
S4. People who seem unsure and uncertain about things lose my respect.	13,9	25,0	13,9	27,8	16,7
S5.On occasion I get overly enthusiastic about things.	5,6	8,3	8,3	41,7	36,1
S6. I rely on intuitive hunches and the feeling of 'rightness' or 'wrongness' when moving toward the solution of a problem.	8,3	8,3	19,4	41,7	22,2
S7. I like hobbies that involve collecting things.	2,8	22,2	8,3	44,4	19,4
S8. If I had to choose from two occupations other than the one that I now have, I would rather be a physician than an explorer.	50,0	16,7	13,9	11,1	8,3
S9. I have a high degree of aesthetic sensitivity.	8,3	11,1	41,7	27,8	8,3
S10. I am much more interested in coming up with new ideas than I am in trying to sell them to others.	11,1	16,7	19,4	41,7	11,1
S11. In evaluating information, the source of it is more important to me than the content.	8,3	16,7	41,7	25,0	8,3
S12. One's own self-respect is much more important than the respect of others.	5,6	11,1	5,6	13,9	63,9
S13. I like work in which I must influence others.	5,6	19,4	25,0	25,0	25,0
S14. People who are willing to entertain 'crackpot' ideas are impractical.	5,6	19,4	50,0	5,6	16,7
S15. When a certain approach to a problem doesn't work, I can quickly reorient my thinking.	2,8	22,2	13,9	44,4	16,7
S16. I am able to more easily change my interests to pursue a job or career than I can change a job to pursue my interests.	11,1	22,2	44,4	11,1	11,1
S17. I can frequently anticipate the solution to my problems.	2,8	16,7	11,1	47,2	22,2
S18. Only fuzzy thinkers resort to metaphors and analogies.	5,6	16,7	63,9	11,1	2,8
S19. I frequently begin work on a problem which I can only dimly sense and not yet express.	5,6	19,4	25,0	25,0	25,0
S20. I feel that hard work is the basic factor in success.	16,7	8,3	13,9	22,2	38,9
S21. I know how to keep my inner impulses in check.	13,9	8,3	5,6	38,9	30,6
S22. I resent things being uncertain and unpredictable.	8,3	36,1	16,7	30,6	8,3
S23. The trouble with many people is that they take things too seriously.	5,6	11,1	25,0	25,0	33,3
S24. I can easily give up immediate gain or comfort to reach the goals I have set.	13,9	8,3	44,4	19,4	13,9
S25. I'm attracted to the mystery of life.	8,3	11,1	5,6	47,2	27,8
S26. I always work with a great deal of certainty that I'm following the correct procedures for solving a particular problem.	8,3	8,3	11,1	44,4	27,8
S27. I believe that a logical step-by-step method is best for solving problems.	8,3	5,6	5,6	50,0	30,6
S28. I spend a great deal of time thinking about what others think of me.	16,7	36,1	25,0	8,3	13,9
S29. It is more important for me to do what I believe to be right than to try to win the approval of others.	2,8	16,7	16,7	33,3	30,6
S30. I am able to stick with difficult problems over extended periods of time.	2,8	13,9	25,0	38,9	19,4

S31. I often get my best ideas when doing nothing in particular.	8,3	19,4	22,2	22,2	27,8
S32. When problem solving, I work faster analyzing the problem and slower when synthesizing the information I've gathered.	11,1	11,1	30,6	33,3	13,9
S33. Daydreaming has provided the impetus for many of my more important projects.	11,1	5,6	13,9	36,1	33,3
S34. I can get along more easily with people if they belong to about the same social and business class as myself.	5,6	25,0	5,6	36,1	27,8
S35. Intuitive hunches are unreliable guides in problem solving.	22,2	27,8	25,0	13,9	11,1
S36. I tend to avoid situations in which I might feel inferior.	13,9	16,7	25,0	36,1	8,3
S37. I like people who follow the rule "business before pleasure".	11,1	13,9	27,8	36,1	11,1
S38. I feel people who strive for perfection are unwise.	11,1	22,2	19,4	27,8	19,4
S39. It is important for me to have a place for everything and everything in its place.	8,3	5,6	13,9	50,0	22,2
S40. I don't like to ask questions that show ignorance.	16,7	27,8	19,4	19,4	16,7
S41. I rather enjoy fooling around with new ideas even if there is no practical payoff.	11,1	13,9	11,1	36,1	27,8
S42.Inability to solve a problem is frequently due to asking the wrong questions.	16,7	5,6	19,4	36,1	22,2
S43. It is a waste of time to analyze one's failures.	61,1	13,9	8,3	11,1	5,6
S44. At times I have so enjoyed the ingenuity of a crook that I hoped he or she would go scot-free.	19,4	11,1	13,9	30,6	25,0
S45. I frequently tend to forget things such as names of people, streets, highways, small towns, etc..	27,8	25,0	16,7	22,2	8,3
S46. To be regarded as a good team member is important to me.	13,9	8,3	8,3	36,1	33,3
S47. I am a thoroughly dependable and responsible person.	11,1	8,3	5,6	41,7	33,3
S48. I prefer to work with others in a team effort rather than solo.	11,1	13,9	30,6	25,0	19,4
S49. I am frequently haunted by my problems and cannot let go of them.	2,8	11,1	8,3	58,3	19,4
S50. If I were a college professor, I would rather teach practical courses than those involving theory.	16,7	0,0	5,6	8,3	69,4

As Table 1 shows, pre-service science teaches mostly gave positive answers to the questions, but their answers to some of the questions showed inconsistency. Pre-service teachers gave inconsistent answers to the following items, among others: "*I am able to more easily change my interests to pursue a job or career than I can change a job to pursue my interests; Only fuzzy thinkers resort to metaphors and analogies; I frequently begin work on a problem which I can only dimly sense and not yet express; I can easily give up immediate gain or comfort to reach the goals I have set; I can get along more easily with people if they belong to about the same social and business class as myself; I tend to avoid situations in which I might feel inferior; To be regarded as a good team member is important to me;* and *I prefer to work with others in a team effort rather than solo*".

Table 2. Themes and codes in pre-service science teachers' definitions of scientific creativity

Themes of scientific creativity	Codes	N
Originality	Originality/ novelty	0
	Difference/ innovation	8
Science knowledge	Science/being scientific	12
	Knowledge	4
Flexibility	In-depth examination	0
	Connecting with other ideas	0
Fluency	Generating many ideas	0
	Generating ideas	5
Product	Invention	1
	Design	2
	Developing a method	1
	Conducting an experiment	1
Imagination	Imagination	2

As Table 2 shows, pre-service science teachers used various concepts when trying to define scientific creativity. The concepts of "science/being scientific" and "difference/innovation" were the most frequently used concepts; followed by the less frequently used "knowledge", "generating ideas", "design", "developing a method", "conducting an experiment", and "imagination"; whereas the concepts of "originality/novelty", "in-

depth examination", "connecting with other ideas", "generating many ideas" were not used at all.

Conclusion and Discussion

Scientific creativity is a creativity skill that is specific to the field of science and that contains the dimensions of personality, family, social environment, cognitive skills, school environment, laboratory approaches, novel activities, environmental diversity, proper learning processes, and field-specific knowledge (Demir, 2014). Shanahan (2009) argues that science students need to learn that scientists are creative individuals who use their imagination to develop hypotheses, make explanations and participate in discussions, and more creative activities are needed to reduce the disparity between students and science.

According to Tekin Gürgen and Bilen (2005), creativity is a developmental skill that emerges in suitable conditions. Creative thinking complements scientific process in science and technology (Akçam, 2007). In order to develop creative scientific thinking skills, multiple learning approaches, methods, and techniques should be constructed, rich educational environments should be created together with a well-structured learning process, starting with counseling for the instructors (Demir, 2014). Indeed, long-term goals for the development of scientific creativity are constrained by the knowledge, skills and abilities of science teachers, and the quality of the education and development opportunities offered to students at all levels of their education (Schmidt, 2010). Wei, Chang, Hsieh, and Yang (2006) argue that conveying information is not the only goal in science education, and that creative learning processes make a big difference in terms of fluency, flexibility, originality and detail.

The major finding of this study is that pre-service science teachers typically gave positive answers to the items of the creativity scale, whereas answers to some of the items were inconsistent. In their descriptions of the concept of scientific creativity, pre-service science teachers most frequently used the concepts of "science/being scientific" and "difference/innovation"; used the concepts of "knowledge", "generating ideas", "design", "developing a method", "conducting an experiment", and "imagination" less frequently; and did not use the concepts of "originality/novelty", "in-depth examination", "connecting with other ideas", "generating many ideas" at all. These findings suggest that the pre-service science teachers' self-assessments of creativity far from satisfactory, and their definitions of scientific creativity are lacking in some respects. A similar conclusion was reached by Newton (2010), who examined pre-service teachers' explanations of simple scientific facts, and found their creativity to be less than expected. It could thus be argued that a lot more attention needs to be paid to developing creativity skills of the pre-service teachers during their training.

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