Chemistry teachers' views of creativity

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Contents

Abstract

The purpose of this study was to determine chemistry teachers' views of creativity. In this study, phenomenology method, one of the qualitative research patterns, was used. The participants of this study were 13 chemistry teachers working in Amasya. A semi-structured interview form was used for data collection. By using NVivo 9 qualitative analysis software, data were coded and themes were created. Findings indicated that the chemistry teachers associated creativity with intelligence and view creativity as an essential factor for problem solving skills and creating novel ideas. Chemistry teachers thought that there were cultural barriers for creativity. It was identified that teachers did not have enough knowledge about

teaching techniques that were effective in developing creative ability of students and believed that the allowed weekly lesson hour and chemistry curriculum wasn't efficient for developing creativity in students.

Keywords: Creativity, Chemistry teachers, Teacher views

Introduction

In today's world, social development can only be possible with the accumulation of novel and original knowledge. This fact conduces to appreciation of creative ideas which enables economic and social development of society and empowerment of the countries that hold creative ideas. The countries recognize the importance of nurturing creativity emphasize this ability in their curriculum. Turkey is one of these developing countries. According to revised National Science Education curriculum, creativity is recognized as an ability that should be fostered in school settings (Ministry of National Education, 2013).

Creativity has been defined in many different ways since ancient times. Runco (2004) investigated definitions of creativity and found that in many articles creativity was defined as the capacity to develop novel and useful ideas, behaviors or products, and tends to be seen as a complex capacity bearing on a mix of individual, situational and cultural variables (as cited in Martinsen, 2011). Creativity theories and definitions can be explained in two groups as implicit and explicit.

Theories that are directly expressed by researchers, psychologists and sociologists are explicit. Researchers and other specialists who use explicit theories bring out creativity testing, and compare creativity in different situations and environments to test their hypothesis about creativity (Seo, Lee and Kim, 2005; Maksić &Pavlović, 2011). Explicit theories of creativity were classified differently in the related literature according to their focused variables and views. These explicit theory categories are: Developmental and Humanist, Psychoanalytic, Behaviorist, Economic, Stage and Componential Process, Cognitive, Problem Solving and Expertise based, Problem finding, Evolutionary, Typological, Systems and Psychometric (Kozbelt, Beghetto and Runco, 2010; Starko, 2010). These theories can be seen at Table 1.

Table 1. Explicit Theories of Creativity

Category	Assumption	Category	Assumption
Developmental and Humanist	Creativity is a natural result of healthy development. Creativity develops over time as a result of interaction between place and person with other persons.	Typological	Creators vary along key individual differences which are related to both micro and macro level factors and can be classified via typologies.
Psychoanalytic	Creativity can be explained with conscious and unconscious processes.	Systems	Creativity is a result of a complex system of interacting and interrelated factors.
Behaviorist	Creativity can be explained with stimulus-response principle.	Psychometric	Creativity can be measured with reliable and valid tests; differentiating it from related constructs (IQ) and highlighting its domain- specific structure.
Economic	Creativity is influenced by market forces and cost-benefit analysis.	Problem solving & Expertise-Based	Creative solutions to problems are results from a rational process which relies on general cognitive processes and domain expertise.
Stage& Componential Process	Creativity proceeds through a series of stages or components. This process can have linear or recursive elements.	Problem Finding	Creative persons proactively engage in a subjective and exploratory process to identify problems to solve.
Cognitive	Creativity is based on ideational thought processes.	Evolutionary (Darwinian)	Eminent creativity results from the evolutionary-like processes of blind generation and selective retention.

*Adapted from Kozbelt, Beghetto and Runco (2010) and Starko (2010)

Implicit theories are our personal theories about any abstract ideational concept or behavior that we have not put into words before, albeit use it while interpreting, evaluating and forming our point of view in several situations (Sternberg, 1985; Runco & Bahleda, 1986; Wickes and Ward, 2006). Unlike explicit theories which were postulated by researchers, implicit theories somehow exist in our minds but

they are yet to be revealed. Runco (1990) stated that because implicit theories are in individuals' minds, they need to be explored. According to this revelation, every person may have an implicit theory about creativity and these implicit theories can be revealed through collecting their ideas about the subject.

Regarding implicit theories and beliefs of creativity, teachers are the most studied subjects because they are among environmental variables that influence students' creativity (Kowalski, 1997; Runco &Johnson, 2002). Practitioner of curriculums and the key to the efficient use of students' potential are teachers and their qualifications. One of these qualifications is teacher views about creativity. In constructivist approach teachers should guide and encourage students to find solutions to problems. As for students, it's expected to construct knowledge by using their prior knowledge. Especially in radical constructivism students can only use their own knowledge to construct new information (Von Glasersfeld, 1991). Considering Turkey's education program which is based on the constructivist approach and teacher and student roles, it is crucial to develop students' creative ability.

Research related with creative education has focused on teacher perceptions and practices in order to nurture creativity (Westby and Dawson, 1995; Park, Oliver and Cramond, 2006). In a study Zhou, Shen, Wang, Neber and Johji (2013) compared teachers' conceptualizations of creativity among China, Germany and Japan. Their results indicated that teachers perceived creative students as imaginative, original, curious and willing to try new things. Additionally, they found cultural differences in perceptions of creativity. As for differences among countries, Chinese teachers thought creativity was influenced by critical thinking and independence. German teachers perceived creativity fostering factors as encouragement and feedback, independence and initiatives. Japanese teachers considered creativity less likely to be developed. Chan and Yuen (2013) investigated teachers of gifted students' perspectives regarding creativity in Hong Kong. They conducted in-depth interviews with 10 teachers and found that teachers used personality and cognitive characteristics to define creative students. They also defined creativity in terms of person, process, product, environment and value and in order to foster creativity they tended to use more open-ended questions. Alkuş and Olgan (2014) investigated views of pre-service and in-service preschool teachers. Their participants focused originality of a creative product while defining creativity. They indicated that although participants were aware of the value of creativity for young children's

development and the need to nurture creativity, they faced obstacles related with unsupportive school administration.

Most of these teacher perception studies used elementary or middle school teachers as their participants. Additionally, domain based (science, art etc.) investigations are relatively less. Especially in science in which creativity is an important variable (Lederman, Abd-el-Khalick, Bell and Schwartz, 2002), there's a need to explore creativity related views because science as a human endeavor affects our world by changing the way we understand and interact with our environment. Major domains of science became more and more valuable since their development influence society. One of these major domains, chemistry as a school science is an essential domain in secondary curriculum. Gabel (1999) argued chemistry education researchers need to think of the future and move forward in the areas that will be of greatest importance in the 21st century. Creativity is one these areas of great importance on shaping future world. According to Kirchhoff (2011) chemists are molecular designers as they apply their skills and knowledge to create new products and processes therefore teaching chemistry as the creative science that it is, rather than as a collection of facts to be memorized, teachers should help students better appreciate the dynamic of chemistry discipline.

Teaching creativity is a new topic of interest in chemistry education research. Trivic, Tomasevic and Vukovic (2012) initiated a pedagogic experiment to investigate the effect of Stoichiometry elaboration by using different teaching/learning methods in divergent thinking and creativity. They chose Stoichiometry because of its convergent and discouraging nature. They presented a model to encourage students to apply their knowledge in a more creative way. They have found positive results regarding creativity development. In a further study Tomasevic and Trivic (2014) investigated Serbian chemistry teachers' views about stimulating the creativity of students. Their findings indicated that majority of the teachers have positive attitudes towards promoting creativity through chemistry. In addition, they stated they used activities which are conducive for nurturing creativity and stressed the use of laboratory and appropriate evaluation criteria for students' creative work. Meyer and Lederman (2013) explored teachers' classroom practice to take a closer look at creativity in science classrooms and they identified pedagogical factors and teacher conceptions which influence creativity among science students. They emphasized science teachers and science teacher educators to consider learning experiences, behavioral expectations and social influences.

For excellence in chemistry lessons, teachers should encourage and identify the students who have potential to be creative and support them. There is a need for further research on teachers' views and implicit theories of creativity and teacher role in nurturing students' creativity. A very few the aforementioned studies regarding creativity have focused on secondary teachers and teachers from different cultural contexts. Additionally, Turkish secondary science teachers; namely chemistry, physics and biology teachers' perceptions and their practices regarding creativity are yet to be investigated. Therefore the aim of this study is to explore chemistry teachers' views about creativity and variables related with creativity. Chemistry teachers' perceptions and beliefs regarding creativity and their practices will be revealed with this study and our findings will add to the existing literature on cultural differences in creativity.

Purpose of the study

The purpose of study is to first, determine chemistry teachers' views about creativity and other variables related with creativity. Secondly we hope to reveal teachers' beliefs and practices regarding creativity and potential the factors behind these beliefs and practices.

Research Problems

1. What are chemistry teachers' views regarding creativity?
2. How do chemistry teachers define creativity?
3. According to chemistry teachers which variables are effective in developing creativity?
4. According to chemistry teachers what are the characteristics of creative people?
5. According to chemistry teachers what are the characteristics of creative products?

Methodology

Research Design

This study is based on qualitative research design which follows phenomenology method to explore chemistry teachers' ideas about creativity because phenomenology focuses on facts that we are aware of but don't have a deep and

detailed understanding of. For studies that investigate facts that are not completely strange to people but at the same time exact meaning of them wasn't perceived, phenomenology forms a good research base (Yıldırım&Şimşek, 2008).

Participants

The sample of the study consisted of 7 male and 6 female participants for a total 13 chemistry teachers working in Amasya in 2012-2013 academic year. Participant's ages varied between 29 and 56. While choosing the participants for this study, convenience sampling was used because most of the chemistry teachers in Amasya were on holiday and those who were not on holiday were responsible for preparing exams for high school students. The teachers were coded as A, B, C, D, E, F, G, H, I, J, K, L and M in order to keep their privacy.

Data Collection

Semi-structured interview form was used to collect data. Interview form consisted of 12 open ended questions and 1 multiple choice question in which teachers can choose three statements that reflects their view. Semi-structured interview form was developed on the basis of the questionnaire used by Diakidoy and Kanari (1999). A language specialist reviewed the questions for validity. Data were collected through interviews with teachers but teachers who wish to respond by writing their answers have responded questions in a space alone. For internal validity, relevant direct quotations were made in order to give further detail to the findings.

Data Analysis

Content analysis, in which the data are firstly coded and then are arranged logically, was used. Data were analyzed by using NVivo 9 qualitative analysis software. First, based on emerging concepts in whole data, the codes and themes were created. While determining themes, literature about creativity was taken into consideration. It was seen that the emerging themes in this research were consistent with each other.

Findings

Themes that emerged through analysis of teachers' responses are: (1) Nature of creativity, (2) Characteristics of creative people, (3) Characteristics of creative product, (4) Factors effecting creativity, (5) Explicit theories about creativity.

Because of the emerging themes, the findings will be investigated under five dimensions as chemistry teachers' ideas about; the nature of creativity, characteristics of creative people, characteristics of creative product, factors effecting creativity and explicit theories about creativity.

1. Findings about chemistry teachers' ideas about the nature of creativity

Teacher responses regarding nature of creativity were coded and according to these codes, it can be said that the teachers saw creativity as novel ideas and problem solving. These codes are shown on Table 2. In their responses, some of the teachers expressed creativity is domain general while some of them said people can only be creative in special domains.

Table 2. Teacher views about nature of creativity

Nature of Creativity	Frequency
Novel ideas	3
Problem solving	4
Creativity Domains	
Domain Specific Creativity	6
General CreativitySz	7

The following comments illustrate teachers' views:

Teacher A: *It is generating new ideas. It could be in any domain.*

Teacher J: *Offering excellent solutions about the subject that cause the problem with an undiscovered way. The domains that people can be creative are out of routine. They enable creating metaphors for new situation and tasks.*

Teacher K: *Developing new knowledge and making discoveries by using one's systematic knowledge accumulation… People can develop different innovations and inventions in any domain. But physics and chemistry are among the most appropriate domains for creativity.*

2. Chemistry teachers views about the characteristics of creative persons

Teachers were asked whether they have had a creative student; if they had, they were asked to define the characteristics of these students. In another question they were asked to talk about a famous person who they identified as creative and this person's

characteristics that make them creative. The data gathered from these two questions composed teachers' views about the characteristics of a creative person. Findings are shown on Table 3.

Table 3. Teacher views of creative people's characteristics

Characteristics of Creative People	Frequency
Intelligent	3
Curious	1
Motivated	2
Productive	5
Explorer	4
Percipient	1
Successful	5
Knowledgeable	5
Has wide interests	4
Ambitious	1
Fast thinker	1
Mindful	5
Independent	2
Respectful	1
Engaged in science lessons	3
Socially responsible	1
Examiner	4
İnsightful	3
İdealist	2
Rule-breaker	4
Gifted	1
Objective	1
Talented	5
Original	11
Emotional	1

As seen from Table 3, teachers mentioned many characteristics of creative people. They used adjectives such as 'engaged in science lessons', 'rule-breaker' and 'respectful' for defining creative people. Teachers also linked intelligence and being gifted with creativity. Statements from two teachers are as following:

> Teacher I: *Yes I have had a creative student. He was independent, successful, respectful and self-confident.*

> Teacher M: *Yes I have a creative student. She likes science lessons, is ambitious. She sees everything before anyone, and is objective-driven.*

Teachers were asked for a famous person's name who they think is creative and why they find this person creative. Examples from teacher comments are given in Table 4.

Table 4. Creative persons according to chemistry teacher

Person	Teacher comments	Frequency
Einstein	*'Einstein made difference with what he has done.*	5
Michael Faraday	*'Faraday thought about situations no else thought before. He is a person that looked in an original way'*	1
Aristotle	*'Aristotle can be a good example. In an eternal sea of his inner world, his ability to propose logical explanations can prove his creativity.*	1
Niels Bohr	*'Niels Bohr proved his creativity with his studies about atoms.'*	1
Fatih Sultan Mehmet	*Fatih Sultan Mehmet is creative because he made his dreams become true.*	1
Vladimir Putin	*'Russian president Putin. He looks like an authoritative politician but he can play piano, he can scuba-dive. I think he is a different person. He is a man of parts. But he's politician identity obscures his other qualities.*	1
A Turkish talk show host	*'He has some work that has never been done before. We can see his intelligence in his work.*	1
A Turkish religious leader	*'He sends teachers (thousands of them) to teach Turkish all over the world (with a little price) so Turkish language can be globally free.*	1
Other scientists	*I think there are a lot of scientists that I don't remember their names. Especially the ones working on global changes.*	1

As seen from Table 4, some chemistry teachers (n=9) gave examples from scientists while other chemistry teachers gave examples from historical persons, politicians, TV hosts and religious leaders.

3. Chemistry teachers views about the characteristics of creative product

Chemistry teachers were asked to list qualities that they think creative products have. Codes and their frequency are shown on Table 5.

Table 5. Chemistry teachers' views about the characteristics of creative products

Codes	Frequency
Practical	1
Functional	8
Ergonomic	1
Open to interpretation	2
Complete	2
Detailed	1
Original	6

As seen from Table 5, teacher views regarding creative products were coded as 'original', 'ergonomic', 'open to interpretation', 'complete', 'practical' 'detailed' and ' functional' and these codes were gathered under 'characteristics of creative product' theme. The most mentioned code was 'functional'. Teacher views about characteristics of creative product are as following:

Teacher A: *Must be original, solve a problem, and be understandable and practical.*

Teacher C: *Must be the best since ever produced. Must be ergonomic and useful and complete so you cannot say 'it would be better if this is different'*

Teacher G: *Everyone could interpret differently and maybe it can have functions more than one.*

4. Chemistry teachers views about the factors effecting creativity

Factors effecting creativity which were gathered from chemistry teachers' responses are shown on Table 6.

Table 6. Chemistry teacher views about factors effecting creativity

Factors effecting creativity	Frequency
Age	2
Gender	10
Family upbringing style	6
Social environment	1
Gender	10
Cultural barriers • Non supportive for every domain • Cultural degeneration • Non democratic family structure • Over protective parents	 2 2 1 1
Education • Positive factors	

• Reinforcement	1
• Education in science and art domains	1
• Teaching methods and techniques	
• Project-based	2
• Contest	1
• Experiment	2
• Observation	3
• Debate	2
• Trial-error learning	1
• Hands-on training	2
• Drama	1
• Brainstorming	1
• Socratic method(question-answer)	1
• Teacher qualities	
• Motivation	1
• Technological literacy	1
• Domain knowledge	2
• Openness to innovation	2
• Learning environment	
• Laboratory	3
• Technological equipment	3
• Special schools for creative students	1
• Democratic classroom environment	5
• Supportive school management	5
• Negative factors	
• Inequality of opportunity	1
• Test anxiety	2
• University entry exam	5
• Intensive curriculum	8
• Insufficient application area	1
• Weekly lesson hour	6
• Teacher centered instruction	1
• Overcrowded classroom	2

Teachers mentioned gender, age, social environment, family upbringing style, education and cultural barriers in their answers. Teachers also referred to positive and negative factors. Perceived positive factors are as listed; learning environment, teacher qualities, education in science and art domains, reinforcement and teaching methods and techniques.

Teachers mentioned that the creative children should be awarded in schools. A teacher stated *'School laboratories are not equipped much. There should be another teacher in charge with us in laboratories. They could orientate students and award students who have done something creative. 2 hours a week is not enough for this.'* Some teachers also stated that education in science and art domains could foster creativity.

They pointed out those teacher qualities which can help nurturing creativity as motivation, domain knowledge, technological literacy and openness to innovations. Teachers also gave examples of methods and techniques that can be used to develop children's creativity. These examples can be seen on Table 6.

Some teachers in this study mentioned that Turkish culture doesn't support creativity enough. These ideas were coded under cultural barriers. Views from three teachers are as follows:

> Teacher D: *Personal and special education lacks in our country. Additionally older individuals have a voice in family and younger are being protected by not giving them any responsibility.*
>
> Teacher F: *There's no democracy culture neither in family nor in society. So there's no environment available for creativity in our educational institutions and in social life.*
>
> Teacher J: *It can be said that our culture supports creativity in socio cultural domains (literature, art etc.). But it is hard to think that our cultural structure is adequate especially in science.*

Gender is a factor that is affecting creativity according to some chemistry teachers. The following two teacher comments illustrate this view:

> Teacher E*: There's a difference between males and females when it comes to creativity. Girls have strong verbal intelligence while boys have numerical intelligence. Girls just work hard that's why boys are more creative I think.*
>
> Teacher H: *I don't' think there is a difference. Both genders could be creative when needed. Females could be creative through their attitudes and abilities. For example they can prepare a meal or create a pattern in embroidery. Oppositely males can work on cars or other machines working with motors.*

About negative factors they associated with education, chemistry teachers mentioned weekly chemistry lesson hour, intensive curriculum, overcrowded classroom, inequality of opportunity, insufficient application areas, text anxiety and teacher centered instruction. Selected teacher statements are as following:

> Teacher A: *Curriculums are very intensive. Application areas and time is insufficient for chemistry education.*

Teacher F: ... *First of all curriculum must not be this intense. I don't think there's much to do for creativity if the college entry exams continue to use multiple choice questions. There are too many concepts and too many educational attainments. Children spend most of their times trying to learn and use those concepts. But they also need some time to imagine.*

Teacher K: *There aren't any opportunities for creativity development because it's too hard for us to motivate students to be creative. There aren't sufficient psychological and environmental conditions for project development in every school.*

5. Chemistry teachers preferred explicit creativity theories

In this study chemistry teachers were given 12 statements related with explicit theories of creativity and they were expected to choose 3 of them which fit their view most. Frequencies of teachers' responses about explicit creativity theories frequencies are given on Table 7.

Table 7. Teachers preferred explicit creativity theories

Creativity Theories	Frequency
Developmental-Humanist	7
Psychoanalytical	1
Behaviorist	3
Economic	3
Evolutionary	1
Problem Solving and Expertise Based	5
Problem Finding	3
Typological	9
Stage and Componential Processes	1
Psychometric	0
Systematic	1
Cognitive	5

Teachers' choices of creativity theories showed that they held similar views supporting typological and developmental-humanist theories. Psychometric view was not supported by any of teachers which indicate that teachers in our sample don't consider creativity as a measurable construct.

Discussion

Chemistry teachers' views of creativity have been explored in this study. According to analysis for the first sub-problem of this research; chemistry teachers generally mentioned novel ideas, problem solving and creativity domains when identifying creativity. This finding is apparent in the literature (Andiliou and Murphy, 2010). Also Emir and Bahar (2003) investigated prospective teachers' and faculty members' views about creativity and similarly they have found that new ideas and problem solving were associated with creativity. Maksić and Pavlović (2011) reported that the educational researchers used originality, novelty and difference as key descriptors of creativity in their study which they investigate implicit theories of Serbian educational researchers on creativity. While many definitions can be made for creativity, there are researchers that explicitly define creativity as novel ideas (MacKinnon, 1962; Sternberg, 1993) and as problem solving (Weisberg, 1995; Isaksen, Dorval & Treffinger, 2000) just like participating chemistry teachers.

Some of the participating teachers mentioned that creativity is domain specific while some of the others mentioned that there's no such thing as general creativity, people can only be creative in particular domains. There's an ongoing debate about this phenomenon. For instance, Plucker (2004) stated creativity is not domain specific although it seems like that and it can be said that there's a general creativity. On the opposite, Sternberg and Lubart (1993) people are creative in different domains. There are researchers who accept both views and point out that it's not important to make discrimination like this. In their Amusement Park Theory, Baer and Kaufman (2005) adopted a view in which creativity could be both domain general and domain specific.

Teachers used many characteristics of creative individuals. The characteristics they mentioned are consistent with previous research (Diakidoy and Phtiaka, 2002; Cheung, Tse and Tsan, 2003; Aljughaiman and Mowrer-Reynolds, 2005). Our analyses have shown that teachers mentioned classroom behaviors such as respectful, rule-breaker and they have an aptitude to define students who are engaged in science lessons are creative. Along with these, teachers also mentioned cognitive traits (e.g. intelligence, percipient and fast thinking). These findings are supported by relevant literature (Saracho, 2012; Lee and Seo, 2006). In a research conducted by Chan and Chan (1999) with teachers in USA and China, traits related with creativity were investigated and it was seen that the teachers in China used cognitive traits while

teachers in USA used behavioral traits to describe creativity. Also Chinese teachers associated socially undesirable traits with creativity in students; they argued that in Chinese culture, nonconforming or expressive behavior can be interpreted as arrogant or rebellious. Same could be argued with Turkish culture which is intolerant to expressive behavior in both children and adults.

Chemistry teachers in this study did not mention important traits such as sense humor, androgyny, tolerance for ambiguity and risk-taking. Reason behind this act could be associated with Turkish culture in which people who have sense of humor are thought to be rebel and are seen as negative figures. Oral and Güncer (1993) investigated teacher perceptions and have demonstrated that creative children are rated as more disruptive in the classroom. According to Hargreaves (1994) "*in post-modern school systems, risk is something to be embraced rather than avoided. Risk-taking fosters learning, adaptability and improvement*" (as cited in Craft, 1998). As teachers' negative attitude towards misbehaving students shape their classroom practices, teachers should take their own risk to serve creative but socially unwanted children.

Teachers in our study identified intelligent and gifted individuals as creative therefore it could be said that chemistry teachers related these concepts with each other. As teachers pointed out, creativity is one of the criteria for being identified as gifted (Renzulli, 1998). According to threshold theory, creativity is a trait that can be seen in individuals who has at least IQ 120, above IQ 120 creativity level starts to drop (Guilford & Christensen,1973; Runco & Albert, 1986; Preckel, Holling and Wiese, 2006). However below IQ 120 and upper, negligible correlations were found between intelligence and creativity (Kim, 2006). Thus, it could be said that intelligence is not a pre-condition for high creativity. Additionally, chemistry teachers were asked to give examples of creative people and some of them gave examples from scientists while other chemistry teachers gave examples from historical persons, politicians, hosts and religious leaders but some of these persons' creativity could be argued.

In third research problem, chemistry teachers' views about the characteristics of creative product were identified. According to literature creative products must be original, adaptable to the real life and useful (Parnes & Treffinger, 1973; Barron & Harrington, 1981; Sawyer, 2006). Chemistry teachers mentioned that creative products are original, ergonomic, practical, functional, open to interpretation,

complete and detailed. It could be said that chemistry teachers mentioned almost all of the qualities of creative products in related literature.

In fifth research problem, chemistry teachers' views about the factors effecting creativity were explored. Teachers mentioned gender, age, social environment, family upbringing style, education, cultural barriers and negative labels. Most male teachers stated that males were more creative than females. Gralewski and Karwowski (2013) reported teachers' ratings of creativity were moderated by gender. This view holds important risks for it could cause the ignorance of females by teachers even if they are creative. Researchers suggest that especially in eastern cultures (Arabic, Turkish etc.) because of cultural barriers and parents' guidance, males become more creative than females (Baer, 1999). However there are conflicting studies about gender differences in creativity (Kousoulas and Mega, 2009) so in order to nurture creativity equally in school context, teachers should be aware of the risks and be open to support all of the students unconditionally.

Teachers mentioned positive and negative factors in their responses. Although creativity is related with intrinsic motivation, teachers argued that creative students should be awarded. Eckhoff (2011) reported teachers considered using frequent praise and use of external awards but they recognized the importance of intrinsic motivation in her study with pre-service teachers. Teachers in our sample stated that creative students should be educated in special schools, creativity should be supported both in school base and in classroom base and technical equipment of learning environment should be appropriate. They also expressed that an important positive factor about developing creativity is teacher's support for creativity. According to chemistry teachers it could be said that teacher traits which support creativity are; motivation, technological literacy, openness to innovation and domain knowledge. Teachers exemplified some techniques like brain storming; project based learning, drama creativity development. These findings are also in line with research conducted by Emir and Bahar (2003) and Tan (2001) in which similar teaching methods were suggested by teachers. Although teachers in our sample did not give examples such as SCAMPER technique, Creative Problem Solving, Good-Bad-Interesting exercise which were based solely on creativity development so it could be said that they may not be aware of these methods.

Teachers generally complained that chemistry education program is too intense and weekly lesson hour for chemistry class does not allow implementing any activities to develop creativity. These issues which were identified by many other researchers in

different contexts are barriers to creativity development (Saarilahti, Cramond and Sieppi, 1999; Tomasevic and Trivic, 2014; Hartley and Plucker, 2014; Kampylis, Berki, Saariluoma, 2009). Also perceptions of cultural barriers were identified. Teachers stated that Turkish culture doesn't support creativity enough. They expressed that parents often behave protective to their children, the existence of nondemocratic family structure, cultural degeneration and creativity not being supported in every domain in Turkish culture.

Explicit theory category of creativity that is generally internalized by chemistry teachers was identified. It was seen that teachers mostly preferred typological theories. Other mostly preferred are developmental-humanist theories, problem solving and expertise based theories and cognitive theories. Typological theories suggest creative people differ in many factors. And these factors could be classified via typologies. In this context it could be said that teachers acknowledge that creative students have different aspects. Another category of creativity that became prominent in this study is developmental-humanist theories. Theories in this group suggest that creativity can be developed over time so it is important for teachers to have this view for developing creativity in schools.

Conclusion

The LLAESSC was conducted with thirty-six participants from 6th, 7th and 8th grades. The activities were aimed to increase their awareness about astronomy, their knowledge about the Earth, planets and certain structures in the universe. These activities were prepared by academicians and staff. It was observed that the participants enjoyed these activities. Besides, the activities motivated and required the students to produce tangible results. As a result the students produced well.

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