Use of Pre-service Science Teacher Creativity in Elementary Science Classrooms

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Abstract
The purpose of this study to determine that how pre-service science teachers (PSTs) in constructivist based and control classrooms differs in terms of features of creativity they use in classrooms. Twenty PSTs who took two semester method course in their undergraduate education were the sample of the study. The only difference from these two groups (10 PSTs for constructivist group, 10 PSTs for non-constructivist group) is that one group has encouraged using 5E model while preparing all of the lesson plans, doing their microteaching in the class and their real teaching in elementary schools. Videotapes, notes from direct observations and lesson plans were reviewed in terms of the features of creativity. For each PSTs videotape analyses and frequency analyses were collected in an attempt to determine the features of creativity. It is apparent that the PSTs in constructivist group were able to use and develop all of the creativity features mentioned. All of these features showed dramatic differences between PSTs experiencing constructivism and those of students in non-constructivist sections. The creativity features measured were more highly developed in PSTs who experienced method course in constructivist classrooms. These PSTs supplied and practiced creativity and constructivist environment in their elementary science class.

1. Introduction
One fundamental aim of science education is to improve science literacy in ways that students can learn new and important concepts and meet other features of current national reforms. Previous research reveals that when solving problems, students can hopefully transfer what they learn to other new situations [8]. The constructivist approach has a vital role in achieving these major goals related to creativity in the classrooms. Research literature review reveals that students learn best if they are actually involved in the learning process [1, 3, 9, 20]. To apply these principles, the constructivist teaching approach considers science in the context of what human experiences develop from the objects and events all persons encounter in the natural word. Doing this provides an environment that is appropriate for all learners to experience real science [12].

The constructivist environment encourages students to have personal relationships with science experiences which prepare them for today as well as for the future. Students work to improve their skills. One major skill enhanced by an constructivist environment is the ability of students to enhance their own personal creativity. Such creativity offers possible solutions while also creating environments suitable for improving students' own personal creativity. By providing a safe environment for exploring, risk taking, and experimentation, constructivism is valued as students seek to apply and enhance their creative skills while solving real problems [10].

No consensus exists about a specific definition of creativity in the literature [7]. Some researchers have defined creativity to be "the kind of thinking that leads to new insights, novel approaches, fresh perspectives, whole new ways of understanding and conceiving things" [6]. Creativity is at the heart of doing real science. It starts with questions! Creativity is enhanced as more science is experienced. Music, poetry, dance, drama, literature, and art obviously require creative thinking and actions that can be identified as examples of employing personal creativity, but, it is experienced in less obvious ways

for science. Science starts with asking questions and critically considering several possible solutions, or dealing with certain presumptions by imagining several different relationships and utilizing one to describe the world in imaginative and different ways [6].
Creativity has been investigated by reaserachers for more than a century. Findings of these studies influenced course objectives, teaching stratagies, and school environments [7]. Torrance (1963) one of the most noted creativity scholars stated that “students in general prefer to learn in creative ways by exploring, manipulating, testing, questioning, experimenting, and testing ideas. All individuals are naturally curious, especially young children; their curiosities and creativity are stimulated by relevant, authentic learning tasks of optimal difficulty and novelty for each student” [13]. Torrance has argued that science provides more opportunities for developing creativity than most other school subjects; it is an idea that reflects the broad support for integrating creativity into both science classes and the curriculum as a whole [14].
The literature indicates clearly that teachers, teaching strategies, learning, and classroom environments all have provocative influences for enhancing student creativity [4,7,15,16,19] but few studies have examined creativity in connection resulting from constructivist instruction. One study [10] did aim to measure the influence of an STS approach on student creativity with respect to questioning, reasoning, and predicting consequences. This study concluded that students taught with an STS approach develop significantly better creativity skills (with the exception of “Questioning” as the primary sub-dimension) than did students taught with traditional methods. Another study investigated student creativity with a sample of 126 seventh and ninth grade girls [11]. The findings revealed significant relationship between high verbal and math IQ scores and student creativity. Appropriate time for thinking creatively, risk taking, investigation of the environment, rewards for creative ideas, and questioning are all components of an environment supporting the improvement of creativity and the constructivist teaching approach [17]. Therefore specific research question of this study is;

1. How do pre-service teachers in constructivist based and control classrooms differ in terms of features of creativity they use in classrooms?

2. Method

2.1. Sample and data collection procedures

Twenty PSTs who took two semester method course in their undergraduate education were the sample of the study. These pre-service science teachers were in the same university and same semester. They were only different section of the class. In their method course of sixth semester, they had thought about the different instructional methods especially 5E model one of the model of the constructivist learning theories. In their method course of seventh semester they need to prepare lesson plans and do microteaching to their peers and instructors in class. In the last semester of undergraduate education they took practicum course and they went elementary school and practiced teaching at least 6 times in semester. They videotaped their teaching. The only difference from these two groups (10 PSTs for experimental group-constructivist group, 10 PSTs for control group- non-constructivist group) of pre-service science teachers is that one group has encouraged using 5E model while preparing all of the lesson plans, doing their microteaching in the class and their real teaching in elementary schools. In constructivist and non-constructivist groups, pre-service teachers were almost equal with respect to gender, socioeconomic levels, class sizes, average grades, both groups also used the same curriculum. The only difference was that constructivist group pre-service teachers classes integrated various activities, and lesson plans with the 5E methodology.
Videotapes, notes from direct observations and lesson plans were reviewed in terms of the features of creativity. For each teacher (10 with constructivist experiences and 10 without any constructivist experiences), videotape analyses and frequency analyses were collected in an attempt to determine the features of creativity.

3. Results

In this study, aspects of creativity that was investigated related to teachers behaviors was showed in Table1.

Table1. Aspects (ASP) of creativity

1. Use of Higher order questions	9. Linkages and validations to ideas/explanations
2. Use of Lower order questions	10. Encouraging students explaining unique ideas suggested for gathering evidence
3. Use of Closed questions	11. Practice differentiating between causes and effects
4. Use of Open questions	12. Use of textbook for identifying new ideas
5. Use of Probing questions	13. Encouraging inquiry activities
6. Use of waiting time after questioning	14. Encouraging student-student discussion
7. Encouraging using higher order science process skills	15. Encouraging students various explanations
8. Encouraging using lower order science process skills	16. Expectation of needed evidence for all proposed explanations

It is apparent that the pre-service science teachers in constructivist group were able to use and develop all of the creativity features mentioned. All of these features showed dramatic differences between pre-service teachers experiencing constructivism and those of students in non-constructivist sections. Specific results are shown in Table 2.

Asp.	Teachers who have constructivist based method course experience										Teachers who have not constructivist based method course experience									
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
1	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx			x		x		x		x	
2	x		x		x		x		x		xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
3			x				x				xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
4	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx			x		x		x			
5	xx	xx	xx	xx	xx	xx	x	xx	xx	xx										
6	xx	xx	x	xx	x	xx	x	x	xx	x	x				x		x			
7	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx				x				x		
8		x				x	x		x		xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
9	xx	x	xx	x	x	xx	x	xx	x	xx		x			x		x			
10	xx	x	xx	x	x	x	x	x	xx	x										
11	xx	x	xx	x	xx	x	xx	x	x	xx		x				x		x		
12		x				x			x		xx	xx	xx	xx	xx	xx	xx	xx	xx	xx
13	x	x	x	x	x	x	x	x	x	x				x				x		
14	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx		x				x		x		
15	xx	xx	x	xx	xx	x	xx	xx	x	xx				x				x		
16	xx	xx	x	xx	xx	x	x	xx	x	xx				x				x		

4. Discussion and Conclusion

The creativity features measured were more highly developed in pre-service teachers who experienced method course in constructivist classrooms. These pre-service science teachers supplied and practiced creativity and constructivist environment in their elementary science class. Constructivist environment provides students with ample opportunities to apply concepts and to actively participate in activities while the textbook-oriented classroom environment offered few such opportunities. Moreover, the traditional classroom settings usually start with an externally directed curriculum (or textbook) in which students are sitting and listening, watching demonstrations, and taking notes. On the other hand, in classroom whose PSTs experienced constructivism, PSTs supplied that students were active participants, following their own line of questions, offering their own responses to questions, and dealing with real-world problems. In addition, the constructivist approach generates a learning environment where creativity is valued, encouraged, modeled, and rewarded [13].
Fleith (2000) indicated the idea that teacher attitudes, strategies, and activities encourage components of classroom environments which improve creativity skills. These features of the learning environment indicate successful constructivist approaches as found in this study. In the constructivist groups, the students designed and carried out their own investigations, while the teachers identified and directed problem-solving activities in the other sections. The findings support previous research which indicate that creative thinking skills can be learned with practice [3] and that education grounded in the constructivist approach promote better development of creativity [3,10,15,19,21,22].
Another factor influencing student creativity may be the level of freedom found in classrooms. According to Erez (2004), freedom is a necessary pre-condition for use and success with enhancing creativity. It is provided with an alternative atmosphere of freedom of choice actions. Too often students cannot formulate original ideas or ask questions in different ways. The constructivist approach contributes to an atmosphere of freedom in which students can generate and raise their own questions without following the textbook or specific teacher directions. This atmosphere of freedom helps students learn how science is relevant to them personally while also improving their creative thinking – both in terms of quantity and quality.
In this study, major differences were found in the extent that creativity skills were identified and used when compared with reults in control groups of preservice science teachers taught with traditional method course. Constructivist approaches are effective in encouraging pre-service science teachers to become more interested in and motivated to teach science. The results strongly support the use of constructivist based method course designed to help teachers consistently employ creativity in their classrooms. University workshops or Professional Development programs should include specific experience with constructivist teaching approaches used in both pre-service and in-service programs. Moreover, creativity issues should be considered while rearranging curricula; teachers should carefully select learning strategies that improve student questioning and creativity skills.

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