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Primary School Teacher Candidates' Reflections on Benefits of Experimental Activities: Before And After Experimental Activities

İlkokul Öğretmen Adaylarının Deney Etkinliklerinin Faydalarına İlişkin Düşünceleri: Deney Etkinlikleri Öncesi ve Sonrası

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Öz

Bu çalışma ilkokul öğretmen adaylarının (n=20) deney etkinliklerinin faydalarına ilişkin kavramlarının, deneysel etkinlikleri içeren ders öncesi ve sonrası, çeşitliliğini ve uygulanan dersin etkisini ortaya çıkarmayı amaçlamakatadır. Çalışmada araştırma deseni olarak fenomenografi, veri olarak ise yazılı cevaplar, raporlar ve görüşme ve gözlem notları kullanılmıştır. Araştırmada temel ve ileri düzey olmak üzere iki çeşit faydaya ulaşılmıştır. Temel faydalar, düşük, nedene dayalı, geleceğe dönük profesyonel plan içeren, ve tutku içeren olmak üzere dört kategoride toplanmıştır. İleri düzey fayda ise, umut verici, orta düzeyde umut verici ve yüksek düzeyde umut verici olmak üzere üç kategoride toplanmıştır. Öğretmen adaylarının fayda kavramları derse bağlı olarak gelişmiştir.

Anahtar Kelimeler

kavramlar
deneysel etkinlikler
fenomenografi
öğretmen adayları
kavramsal değişim

Abstract

The present study aims to reveal the variety in primary school teacher candidates' (n=20) reflections on benefits of experimental activities (EA), both before and after course including EA, as well as any improvements that occurred. Phenomenography was utilized, while written responses and reports, interviews and observation notes were used as the data. Two types of benefits, fundamental and advance emerge. Fundamental benefits emerged in four categories, namely low benefit, benefit with reasoning, benefit with a future professional plan and benefit with passion. Advance level benefits were captured in three categories, namely promising, moderately promising and highly promising. Overall, Primary School Teacher Candidates' (PSTCs') PSTCs' benefit conceptions improved as a result of the course.

Keywords

conceptions
experimental activities
phenomenography
teacher candidates
conceptual change

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1. Introduction

Among a variety of aims, Teacher Training Programs constitute Laboratory Work to prepare Primary School Teacher Candidates (PSTC) for their profession. Teaching programs require PSTCs to be equipped with the necessary skills to engage and manage their future primary school students in Experimental Activities. Different terminology has been utilized for school activities, including experiments. The term Experimental Activities (EA) is preferred throughout this study to represent a group of activities that constitute conducting experiments, whether in a laboratory or outside, in order to understand any science phenomenon.

Theoretical Framework

The majority of researchers and specifically science educators rely on EA. Its main tenet is that Science, Physics, Chemistry, and Biology lessons are fruitless unless EA is integrated into teaching. The benefits of EA to learners were emphasized by Piaget and Bruner (Bruner, 1960, p. 14; Piaget, 1986, p. 705). Furthermore, Piaget stated that during EA, teachers should take the risk of creating erroneous ideas, although they are only temporary stations to reach final scientific knowledge (Piaget, 1973). More recent research has specifically shown that there are a significant number and variety of benefits that can be achieved from experimentation for students (Ferreira, Porteiro, & Pitarma, 2015; Mafra, Lima, & Carvalho 2015; Sarikaya, Güven, Göksu, & Aka, 2010; Trnova & Trna 2015). Varma (2014) emphasized that elementary school students benefits concerning science instruction are centered on EA.

Reasoning Behind the Benefits

Researchers, teachers, and students have stated underlying theoretical and practical aspects explaining the reasoning to support EA. Bustamante and Aleixandre (as cited in Ferreira et al., 2015) stated that experiments familiarize children with certain phenomena. Havu-Nuutinen (2005), in a study with young children, showed that there was conceptual change to develop more scientifically complete theories. Arends (1995) (as cited in Ferreira et al., 2015) stated that some of the aspects are participation, involvement, sharing ideas and learning. On the other hand, reviewing the literature, Satterthwait (2010) identified three factors that explain the success of the hands-on science activities, namely cooperative learning, object-mediated learning and embodied experience. She based collaborative learning mainly on social constructivism theory, regarding student communication during the group work. The next factor facilitates learning by involving the students in the manipulation of objects. According to Satterthwait, the manipulation of three-dimensional objects delivers an event reality, which attracts learners' attention and curiosity and provides the students with the opportunity to play with and enjoy the objects and equipment. Lastly, she linked the embodiment factor with object-mediated learning and described embodiment as the movement of the body. Researchers tend to classify the benefits in the same manner that are aimed by the current study. For example, Tiberghien, Vellard, Marechal, and Buty (2001) grouped certain advantages of EA for students. In their list, they categorized the objectives of learning in two groups, namely content and process. In the content group, they included learning that concerns phenomena, concepts, finding patterns and theory. In their process group, they recorded learning that concerns instrument usage, conducting a standard procedure, planning an investigation, processing data, using data and reporting.

Dunlop, Compton, Clarke, and McKelvey (2015) found that primary school teachers consider EA as an excellent method for achieving teaching objectives. Teachers in an in-service project in Sweden stated that EA is an important part of science education, because it connects theory to practice and familiarizes students with scientific objects and phenomena. EA is also interesting and enjoyable for students, teaches students laboratory skills and provides the opportunity to delete misconceptions (Ottander & Grelsson, 2006). Additionally, it was found that pre-service primary school teachers' believe that EA is effective in fostering attentive participation in learning (Newton & Newton, 2011).

Students themselves have stated that there are various reasons for the benefits of EA (Gunel, Kabatas Memis, & Buyukkasap, 2010; Kampa, Neumann, Heitmann, & Kremer, 2016). In a study by Martinez and Haertel (1991), a sample of seventh-grade students stated that experiments are interesting and the discovery approach attracts them. Additionally, they stated that they liked doing something different, being responsible for their own learning and having the ability to manipulate things and communicate with their friends about it. Research was conducted by Dunlop et al. (2015) with 8-11 years old students to evaluate a kind of inquiry (Community of Scientific Enquiry strategy) implemented in their classes. The students expressed favorable statements concerning the experimentation. They stated that the EA they experienced made them feel like scientists, which they found enjoyable, and made them change their beliefs concerning experiments and increased their sense of enjoyment in the science classes.

The need to include EA in schools and teacher training programs thus arises as a matter of necessity. Educational stakeholders are already aware of the importance of including EA, and attempts were made to implement EA in education in the 1950s. EA approaches were intended to be incorporated into the Turkish science curriculum since the mid-1960s by programs, such as Integrated Secondary School Science, PSSC and BSCS (Baysen, 2003). More recent Turkish Science and Technology lesson teaching programs have continued to place importance on EA (Ministry of National Education, 2005, 2013).

Despite the numerous beneficiary discussions regarding EA, contradictory results concerning the effectiveness or benefits of EA have also been stated (Taylor-Robertson, 1984). Researchers have focused revealing the reasoning behind this outcome. These results may be attributed to students' characteristics, such as their learning habits. For example, students may ignore negative experimental results, which can in turn cause significant deficits in improvement (Berry, Mulhall, Gunstone & Loughran, 1999). Yip (1999) found similar results when working with science teachers. Another important example from Hodson (1996) showed that students need significant guidance in reaching the goals of the EA, otherwise, they will not be able to follow scientific methods, discover cause and effect relations and may even not be able to draw conclusions on the designs they have reached. One other attribution can be made solely to the characteristics of EA. For example, Abrahams and Millar (2008) stated that EA itself is not particularly beneficial as it can lead the students to use scientific knowledge that is already know and does not encourage them to depend on the data collected in the experiment. Improper teaching can also lead to ineffective conclusions. According to the findings of Berry et al. (1999), students focused on completing experiments and with the correct answers follow a cookbook procedural style. Additionally, Berry et al. (1999) also found that students may capitulate easily during the laboratory work. On the other hand, Dunlop et al. (2015) warned about the experimental activities procedures, such as concerns about engagement, preparation and communication behavior among students and the duration of the class. The type of experimentation can distort the process. For example, Bigozzi, Tarchi, Falsini, and Fiorentini (2014), criticized the use of confirmatory experiments as they are a way of transferring knowledge. Lastly, Zhao and Thomas (2016) found that students need to memorize procedures to conduct experiments, a misconception preventing the appropriate utilization of EA.

Schooling Level and Experimentations

Teacher dominance can vary significantly in EA, depending on the school level. While primary school teachers may allow students the freedom to discover, in secondary schools, teachers should direct their students in relatively more planned, 'cook-booked,' objective dependent EA. This aspect leads to differentiations in the students' perspective. In the former, students may unconsciously take more responsibility, controlling their actions, and each student is free to choose EA reflecting a constructivist approach; however, the latter is dominated by the teacher, regardless of whether students are ready for that particular kind and level of instruction or not. Thus, there is more opportunity for primary students to engage in EA enthusiastically, while secondary school students are faced with more rigid EA. This discussion concludes with the belief that implementing EA in primary school education is probably easier than in high schools.

Contrary to this discussion, studies on primary school teachers in Turkey have shown that they experience difficulties in implementing EA in their courses (Cepni, Kucuk, & Ayvacı 2003; Dindar & Yaman, 2003; Dursun, 2003; Kozandag, 2001; Oz, 2007). Boz and Boz (2005) summarized the reasoning behind the problems with implementing EA in Turkish schools. One of them is a lack of experimental resources, because the equipment required for the experiments found in the books distributed by the Ministry of National Education can only be found in laboratories that have adequate funding. Large class sizes impede EA; teachers do not find sufficient time to manage the class for EA. Lastly, the national university entrance exam taken at the end of secondary schools do not encourage the use of EA because it assesses knowledge and tests solution skills rather than EA competencies. Additionally, Bilaloglu, Aslan, and Arnas (2008) found that preschool teachers do not feel that they are capable of implementing EA.

In summary, the educational community, including students, believes that EA is beneficial because they think that EA creates learning in practical conditions. Researchers, on the other hand, consolidate EA benefits, grounding it through theoretical reasoning. Nevertheless, primary and secondary school teachers find it impossible to implement EA in classes as an inevitable fate, as a result of many of the reasons mentioned above. This is also a common belief among educators and society in the Turkish context.

Purpose and Research Questions

The present study aims to reveal PSTCs' conceptions regarding the benefits of EA. The current study not only attempts to determine the level of understanding of a group of PSTCs, but also if any enhancement can be made through a course including EA. To the researchers' knowledge, no research has concentrated on teacher candidates' conceptions regarding the benefits of EA in primary schools. The research specifically seeks to answer the following research questions:

1. What are the PSTC'S initial and after course conceptions of EA regarding:
   i. The fundamental level benefits of,
   a. Cognitive domain, b. Affective domain, c. Psychomotor domain, d. Process skills, e. Group work?
   ii. Advance level benefits.
2. Can EA improve PSTC's conceptions regarding the benefits of EA?

The issues examined regarding EA in the present study are relevant for researchers, educators and policymakers interested in gaining deeper insights into science learning and improving PSTCs' skills and thinking for future applications.

2. Methodical Considerations

Qualitative approaches in science education research are followed by a large number of educational researchers. The present research study follows one of the qualitative research methods, namely phenomenography.

Phenomenography

Phenomenography concentrates on revealing the variation of qualitatively different ways in which people experience any particular phenomenon (Brante, Olander, Holmquist, & Palla, 2015) and it aims to describe that variation. Phenomenographers state that people comprehend any phenomenon with different levels of awareness and people can be grouped as those with a profound understanding and those with a superficial understanding. Accordingly, phenomenographers believe that people's experiences can be grouped in a limited number of categories, and there are similarities and differences in experiences. Phenomenographers interpret and thus group people's experiences in different categories, or categories of description. The categories should be different from each other, and each category should explain a particular experience. These categories of description form outcome space. Outcome space presents categories of description and the relations between them, which are mostly hierarchical. Phenomenography focuses on the variation of all participants' thinking and thus does not intend to report each participants' thinking but all the participants' collectively, so it does not state that what is revealed is a person's most typical or advanced experience, but intends to contain each experience related to the considered phenomenon. Phenomenography deals with experiences after the implementation of a new learning process. Like other qualitative research methods, phenomenographers do not generalize findings to a population. In other words, their population only consists of those participating in the particular research. Phenomenography takes a small number of participants who have a particular common character, for the purposes of data collection (Gullberg, Kellner, Attorps, Thoren, & Tarneberg, 2008; Marton & Booth 1997, pp. 110-136).

Research Design and Procedure

The present study investigates the PSTCs' conception variations in terms of the benefit of EA. As learning is an outcome of any period of a process, the present study deals with the learning outcomes both before and after a course including EA. This aspect of the present study differentiates it from those found in the literature regarding the benefits of EA.

Participants and Their Backgrounds

In total, 20 PSTCs (sixteen females and four males) attending the same class participated in the research voluntarily. The PSTCs were between 20 and 21 years old and in the second year of their teacher training program (4 years in total). All the participants had taken science, physics, and chemistry and biology courses in their education, which also had experiments as a program requirement. Upon graduation, the PSTCs' in the teacher training program will be qualified to work as teachers in primary schools.

Research Setting

The research started at the beginning of the 2015-16 fall semester in order to reveal the PSTCs' initial experimentation conception benefits. The study was held throughout the duration of the "Natural Physical and Chemical Changes" course, which lasted four months. The researcher was also the teacher-researcher. The first few lessons were used to teach the PSTCs how to write an experiment report, how to prepare the laboratory conditions and how explain the course program. The course consisted of three hours each week: one hour on Fridays and two hours on Mondays. The PSTCs were in seven groups; six groups consisted of three PSTCs, while one group included two PSTCs. Each PSTC conducted 18-30 experiments and wrote reports for each of these experiments. The PSTCs designed experimental settings themselves that were appropriate for the goals of the experiments included in the primary school program. The PSTCs were free to select any science concept as a goal, but had to use a different concept at each setting.

Data Collection

Three data types were collected, namely written materials and reports, interviews and observations. Written materials using open-ended questions is one approach for data collection in phenomenography (Crawford, Gordon, Nicholas, & Prosser, 1994; Loughland, Reid, & Petocz, 2002), other than interviews. Written materials were the responses to an open-ended question asked before and after the course: Explain your experience regarding science experiments, during your secondary schooling/last term?, as well as the PSTCs' reports of the experiments. The second data type is based on short interviews which include communications between the researcher and the PSTC/s and among the PSTCs during the courses. The last data type collected was observational, in which notes were taken during and after the courses.

Measures were taken to increase trustworthiness. The researcher did not respond, but recorded the PSTCs' spontaneous declarations concerning the use of experimentation as a method, so as not to influence the PSTCs. Observations were reported as observation notes, and spontaneous declarations showing the PSCTs' feelings and thinking regarding experimentation during the courses were reported immediately after each course, not in the presence of the PSTCs. Additionally, the researcher took short notes whenever necessary in order not to forget any important scene or occurrence while the experiments were ongoing in the Lab. Prep. Room. Five randomly chosen PSTCs' reports, from the beginning, the middle and the end of the school term were analyzed by the researcher's colleague in order to determine if there was any behavior change regarding EA. Similarly, the same research partner attended the laboratory three times as a guest (nonparticipant observer) to determine any behavior change related to the use of EA.

Analyzing and Categorizing the Data

The responses to the central question (What were your experiences regarding science experiments, during your secondary schooling/ last term?) were accepted as the primary data in the present research. However, other data have importance in the coding and categorization processes as well.

A. Analysis of the written responses to the main question.

The iterative method of reading, which is the analysis procedure proposed by phenomenographers, was followed. Each reading changed the data focused until themes emerged and related aspects of the data were determined. Thus, the variety of the PSTCs' conceptions of the experimentation benefits both before and after course were targeted and no other data was included (Marton & Booth, 1997, pp. 133-134). All responses describing the experiment benefits collected before and after the course were grouped separately to form a data pool (Marton & Booth, 1997, p. 133).

B. Analysis of the a) Reports, b) Interview notes and c) Observation notes.

The iterative method of reading was followed for analyzing the statements and notes on the responses to the questions.

a) Reports. The reports that were required from each PSTC included headings and subheadings. The last title of the report was 'Comment,' and was defined as "comment on your and your groups' experience about the experiment you conducted today". These comments predominantly included several sentences such as: "…it was interesting to find out that…."

b) Interview Notes. Interviews and spontaneous declarations during the courses made by the PSTCs concerning their experiences concerning EA were analyzed. Comments that were made whenever the researcher was away from that particular group but could hear the discussion were also listed in these notes. For example, a girl said to her team members: "…Guys, are you aware that we do not need to look at the experiment book anymore!"

c) Observation Notes. These notes were used to consolidate the data collected by the main question, interviews, and reports to increase trustworthiness. For example, the researcher saw that as the course progressed, the PSTCs even laughed during the EAs showing that they were happy and relaxed. Another example gave an indication of development when a PSTC shouted with excitement to the researcher, saying "Sir, do you see that the water is not pouring out anymore", demonstrating psychomotor development during the course, and supporting her response to the main question in the research: "…EA advanced our psychomotor skills". Those not stated by the PSTCs afterward were neglected, because phenomenography depends on others' conceptions, not the researchers'. The researcher experiences how others experience any particular phenomenon (Marton & Booth, 1997, p. 136).

Analysis of data gathered through written responses to the main question, reports (comments), interview notes and observation notes were analyzed first separately and then considered together to finalize the categorization and to determine the results. As the researcher and his colleague agreed in every aspect, the researcher did not record his colleague's observation and analysis results separately.

3. Results

The results revealed the benefit conceptions of the PSTC's both before EA and after EA, thus stating the effect of EA (Table. 1). The PSTC's benefit conceptions in the Teacher Training Program were accepted as PSTC's before EA, while benefit conceptions after the EA implemented in the present study were accepted as benefit conceptions after EA.

Before EA

PSTCs were in favor of utilizing EA in primary schools. Statements covered only two subsections: Cognitive and Affective, grouped in the Fundamental Benefits section.

1. Fundamental Benefits:

Fundamental level benefits are grouped in subsections namely, Cognitive and Affective.

I. Cognitive Domain. Cognitive Domain was captured in two categories: Low Benefit and Benefit with Reasoning.

a. Low Benefit. The PSTC's stated that EA is important. For example, one girl stated that:

"We didn't do enough experiments in our classes during learning; I'm very sorry about this."

b. Benefit with Reasoning. The PSTC's stated with reasoning why EA is important. For example, a boy stated clearly:

"If we did experiments, this would enhance our learning in science subjects."

II. Affective Domain. Similar to the Cognitive domain, the Affective domain was captured in two categories. Low Benefit and Benefit with Reasoning.

a. Low Benefit. PSTC's stated that EA enhances affective learning goals. For example, one girl clearly stated that:

"EA enhances affective learning."

b. Benefit with Reasoning. PSTC's stated with reasoning why EA enhances affective learning goals. For example, a boy stated:

… "The experiment carried out by my teacher changed my attitude toward the environment forever."

Table 1. PSTC's Benefit Conceptions of EA

S*	SS**	EA	Category	Description
Fundamental	Cognitive	Be***	Low Benefit.	*Low Benefit regarding improving cognitive, affective, psychomotor, process skills and group work. Explanations do not include any plan for professional life, reasoning, and passion.
		Be&Af****	Benefit with reasoning.	**Benefit with reasoning about improving cognitive, affective, psychomotor, process skills and group work. Explanations include reasoning but no plans for professional life and passion.
		Af	Benefit with professional plan.	***Benefit with professional plan about improving cognitive, affective, psychomotor, process skills and group work. Explanations include reasoning and plans for professional life, but not passion.
	Affective	Be	Low Benefit.	****Benefit with passion by improving their cognitive, affective, psychomotor, process skills and group work. Explanations include reasoning, future plans for professional life and passion.
		Be&Af	Benefit with reasoning.	
		Af	Benefit with professional plan.	
		Af	Benefit with passion.	
	Psychomotor	Af	Benefit with reasoning.	
			Benefit with professional plan.	
	Process Skills / Group work	Af	Benefit with reasoning.	
			Benefit with future professional plan.	
			Benefit with passion.	
Advance		Af	Promising.	**Promising about utilizing EA in professional life but no reasoning and no passion.
			Moderately Promising.	***Moderately Promising about utilizing EA in professional life, include reasoning but not passion.
			Highly Promising.	****Highly Promising about utilizing EA in professional life, include passion.

**S: Section; **SS: Sub-section; ***Be: Before; ****Af: After*

After EA

Benefits stated after EA by the PSTCs can be organized into two main sections, namely Fundamental and Advance Level Benefits after EA. Fundamental benefits are those stated concerning the benefits improving Cognitive, Affective and Psychomotor domains, Process Skills and Group-Work. Advance Level benefits are those encapsulating utilizing EA in future professional life, and those feelings for future professional EA activities, indicated by one girl who stated, "I felt like a hero, because during EAs, I taught my colleagues".

1. Fundamental Benefits: Fundamental level benefits are grouped in subsections, namely Cognitive, Affective, Psychomotor, Process Skills and Group work.

I. Cognitive Domain: Cognitive Domain benefit was captured in two categories, Benefit with Reasoning and Benefit with a Future Professional Life Plan.

a. Benefit With Reasons. PSTC's stated with reasoning why EA is beneficial. The PSTC's stated that EA confirmed previous learning, where one of them clearly stated:

"EA confirmed my prior knowledge,"

One other PSTC stated that EA rectified mistakes from their previous education:

"EA gave us the chance to realize how many misconceptions we had and to fix them",

b. Benefit with a future professional life plan. PSTCs stated that the knowledge learned in the present EA would enhance their future professional lives. A statement exemplifying this category is:

"EA improved the material knowledge that we will need in our professional lives,"

II. Affective Domain: PSTC's Affective Domain benefit was captured in three categories. Benefit with reasoning, Benefit with future working life and Benefit with passion (excitement, desire, sadness, anger, etc.)

a. Benefit with reasoning. PSTC's stated with reasoning why EA is beneficial regarding Affective Domain. For example, one boy stated:

"EA taught us to be patient and insistent while experimenting, to do each experiment more than once, because nature sometimes keeps its order as a secret so we must explore it".

EA also improved the PSTC's curiosity. One girl stated:

"EA developed my curiosity about how things work around me."

b. Benefit with a future professional life plan. PSTCs stated they would utilize EA in their future professional lives. EA motivates the PSTCs to take responsibilities. For example, a girl stated:

"EA made me believe in myself in terms of taking responsibilities."

c. Benefit with passion. PSTCs stated their future plans with passion. For example, one girl stated:

"I enjoyed doing EA very much. I can imagine how much my future students will enjoy it!"

III. Psychomotor Domain: Psychomotor Domain benefits were captured in two categories. These are Benefit with reasoning and Benefit with future professional life.

a. Benefit with reasoning. PSTC's stated with reasoning why EA is beneficial for the psychomotor domain. For example one PSTC stated:

"Now, I can skillfully use my fingers."

b. Benefit with future professional life. PSTC's stated benefits for their future working lives regarding the psychomotor domain. For example, one PSTC stated:

"I know that I will be successful while conducting experiments in front of the students."

IV. Process Skills. Process Skills benefits were captured in three categories. Benefit with reasoning, Benefit with future professional life and Benefit with passion.

a. Benefit with reasoning. PSTC's stated the benefits of EA regarding Process Skills with reasoning. For example, one PSTC stated:

"EA improved our observation skills … I can observe events more critically now."

Other skills PSTCs stated are long-term focusing, interpretation, reporting, spontaneous decision making, and problem-solving, conducting processes in a stepwise fashion, organization and planning and reasoning strategies and skills.

b. Benefit with future professional life. PSTC's stated the benefits of EA regarding Process Skills with professional life. For example, one PSTC stated:

"...In the balloon inflating experiment, we were not successful. We analyzed the steps in reverse in order to determine what we did wrong". At the end, we found that the balloon we used had a hole!"… "Now I know, what I will do whenever something goes wrong … I feel more confident for the future."

c. Benefit with passion. PSTC's stated the benefits of EA regarding Process Skills with passion. For example, one PSTC stated:

"Traditional teaching approaches do not give us the opportunity to experience and explore the environment in the same way that EA does."

V. Group-Work. Group work benefits were captured in three categories. Benefit with reasoning, Benefit with future professional life and Benefit with passion.

a. Benefit with reasoning. PSTC's stated with reasoning why EA is beneficial for Group work. For example, one PSTC stated:

"EA improved our group work; now we know how we can share responsibilities between us and work in harmony"

b. Benefit with future professional life. PSTC's stated the benefits for their future professional lives. For example, one PSTC stated:

"I have confidence that I will be able to do group work in my working life."

c. Benefit with passion. PSTC's stated the benefits of EA regarding Group work with passion. For example, one PSTC stated:

"We did the preparation for the experiments and the experiments together …it was well organized…, together with my colleagues!"

One girl clearly stated her passion regarding the Group-Work benefit of the EA:

"EA enabled us to learn to work as a group"…. "This was missing for my entire school life" … "…it was enjoyable and useful for my working life, to learn together".

2. Advanced Level Benefits: Advance level benefits include those benefits which are related to future EA applications. Advanced level benefits were captured in three categories, namely, a) Promising, b) Moderately Promising and c) Highly Promising. While Promising only included those stated that they would use EA in their professional lives, Moderately Promising included the future application with reasoning, and finally, Highly Promising included the same as the others, but also with passion.

a. Promising. EA is going to be used in PSTCs' future teaching. This group's statements do not include reasoning, the reasons why EA is beneficial for primary school teaching and do not include any passion. One girl clearly stated this:

"… I will implement an experiment corner in my class…."

b. Moderately Promising. EA will be used in the PSTCs' future teaching. This group does include reasoning, but lacks passion. A girl clearly stated the reasoning behind why she would utilize EA in her professional life:

"EA enables us to concretize the electric charge concept."

A boy emphasized the reasoning as the ability to uncover the secrets of world:

"I will utilize EA in my future lessons so that I will make my students confident in discovering the rules and secrets of the world."

EA eradicates superstitious beliefs. A girl indicated this by saying:

"In our experiment, we saw how a rainbow could be created, thus EA shows that phenomena can be explained rationally, and they are not based on some spiritual forces."

c. Highly Promising. EA is going to be used in PSTCs' future teaching including reasoning and passion. A girl asserted:

"EA is not only beneficial today …, but also in my future professional life, because I understand that by utilizing EA, I can also teach every science subject and considerably more effectively to every child."

Another girl stated with sadness:

"I realized sadly that in my primary and secondary schooling we did not have enough EA."

Anger was also evident in the PSTCs. A boy stated:

"I feel angry because none of my former teachers have done such experiments in my schooling before."

The excitement was felt in every PSTCs' comments:

"The experiment was very discrepant for us. I'm sure we can use it in our future teaching, it is going to be interesting for our future students."

4. Discussion

PSTCs were found to be in favor of utilizing EA in primary schools throughout the present study, which is consistent with many previous research studies (For example: Ferreira et al., 2015; Mafra et al., 2015; Sarikaya et al., 2010; Trnova & Trna 2015; Varma, 2014). Being in favor of using EA in schools is an expected result, because implementing EA in schools has been desired for many years. PSTCs' benefit and advance benefit conceptions emerged in qualitatively different categories of description, which are hierarchically related. There is a variation among PSTCs' EA fundamental benefit conceptions of cognitive, affective, psychomotor, process skills and group work. A similar variation has been revealed in the PSTCs' EA advanced benefit conceptions. It is important to understand the variation of the PSTCs conceptions concerning the issue while implementing the teacher training curriculum. This is because according to this finding, any teacher candidate can have different understandings regarding the issue. Teacher candidate trainers should be aware of this variation in order to be prepared for their students.

Before the EA was implemented, the PSTCs were not as forthright about the benefits of EA, they did not provide details to support their claim, and presented the benefits but superficially and in a clichéd manner (Baysen & Baysen, 2013). Additionally, benefits before EA were only concerned only with cognitive aspects, such as rectifying misconceptions (Baysen, Baysen, & Çakmak, 2017) and affective domains, constituting only part of the fundamental level benefits. PSTCs' thinking is accumulated and did not vary significantly in terms of the benefits, low benefits, and benefits with reasoning. PSTCs showed hopelessness for the future, consistent with Bilaloglu et al. (2008). Before the present EA, utilization was not included in any plan for their professional lives. However, after implementation, more benefits, as well as frequent and favorable statements that were more complex, more passionate and that revealed a greater variety of advantages were attained, and were categorized this time as fundamental and advanced level benefits. Additionally after EA, the fundamental level benefits constituted not only cognitive and affective domains but also psychomotor domain and aspects of process skills and group work. Similarly a significant change was attained in utilizing the EA professionally. Thus, the results indicate that change was caused by EA during the present research.

The present study concluded that conceptual change was achieved, which is consistent with Kutluca and Aydın (2016), but contradicts many other studies regarding implementing EA (Cepni et al., 2003; Dindar & Yaman 2003; Dursun 2003; Kozandag, 2001; Oz, 2007). Although PSTCs lacked real EA conceptions before the EA followed during the present research, they were already in favor of the concept. This finding is thought to enhance EA implementation during the current study. These findings are encouraging. It demonstrates that courses including EA can change teacher candidates' conceptions to EA. However, the researcher is still cautious about the results. A longitudinal study covering PSTCs' professional lives should be included before deciding the success of courses including EA. The implemented behavior asserted should be applied in the students' professional lives and must be considerably permanent. Thus, the change from the content-oriented classroom to the EA approach still seems to be challenging.

5. References

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