Çetinkaya, M.& Özyürek, C. (2019). The effect of inquiry-based science activities on prospective science teachers' scientific process skills. *International Online Journal of Education and Teaching (IOJET),* *6*(1). 56-70. http://www.iojet.org/index.php/IOJET/article/view/412

Received: 13.04.2018
Received in revised form: 01.10.2018
Accepted: 31.10.2018

THE EFFECT OF INQUIRY-BASED SCIENCE ACTIVITIES ON PROSPECTIVE SCIENCE TEACHERS' SCIENTIFIC PROCESS SKILLS

Research Article

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Abstract

Inquiry skill is the most important factor in the development of the scientific processes of prospective science teachers. The objective of this study is to research the effect of using inquiry-based activities on the development of scientific process skills of prospective science teachers. The research group of the study consists of students studying in their third year of science teaching department at Ordu University (n=32). Inquiry-based activities were conducted on prospective teachers for three months within the nature of the science course. Mixed research design, which uses quantitative and qualitative research methods together, was used in this study. As the quantitative data collection tool, a 36-item of scientific process skills scale, which had Cronbach Alpha internal consistency coefficient of .70, was used as pre-test-post-test. SPSS 17 program was used for data analysis and "t-test for dependent samples" was conducted. In the qualitative part of our research, "content analysis" approach was used. Descriptive analysis was conducted on the content of interviews with prospective teachers and observation reports. It was concluded through quantitative and qualitative research analyses that inquiry-based science activities significantly increased scientific process skills of prospective science teachers positively. It is recommended that researchers who conduct studies to increase scientific process skills should use inquiry-based activities.

Keywords: inquiry, nature of science, science education, scientific process skills.

1. Introduction

Science education for the development of an individual's mental process skills requires active participation in the process. The most important factor in science education is an inquiry. Inquiry-based science education enables the individual to form positive attitudes towards learning while developing the learning skills of an individual (Karamustafaoğlu & Havuz, 2016). Inquiry-based education approach has taken its place among teaching programs with a recently increasing significance. Research-inquiry teaching approach has a very significant place for science subjects which do not mean anything when memorized. The first reflections of this significance can be seen in science and technology lesson teaching program, which was revised in 2013. Instead of the previous program which included predominantly constructivist teaching model principles and strategies, research-inquiry based teaching approach was adapted. In the updated curriculum, teachers were asked to prepare activities suitable for research-inquiry based teaching approach and to apply these in their lessons (MoNE, 2013). It can be seen that a multi-disciplinary approach is adapted in the science lesson teaching program, which was last updated in 2018, and research and inquiry-based learning strategy is used as a base. Media which will enable students to learn information significantly and

permanently are recommended to be designed on the basis of research-inquiry strategy. In creating this kind of media, it is also predicted to make use of extracurricular informal learning media (MoNE, 2018).

The Researches based on questioning highlight that questioning skills are the starting point of individual development leading to higher success (Kim, 2011; Quigley et al., 2011; Lee & Buxton 2013). It is reported that the applications based on research and questioning contribute the development of science success, lab and cognitive skills of the students in a positive way (Palmer, 2009; Bulunuz et al., 2012; Baker, 2013; Lee & Buxton, 2013; Kim, 2016). In this study, it is emphasized that students should actively be included in the process to reach the success of the questioning based on education. Psychologists and pedagogues agree on the idea that active participation of the students to the educational activities plays an effective role in academic success (Freeman et al., 2014; Lazonder & Harmsen, 2016). However, the question of how the students participate in the learning process is still on the agenda. The questioning abilities of the students should be improved to take part in the process actively. The methods based on questioning provide learning of the students about the subject through self-directional questioning. "By questioning as a scientist", the students can not only learn scientific knowledge but also scientific events existing across the world (International Science Benchmarking Report, 2010).

There exists questioning in sciences and the students should have enough information about how they question the data. The activities and events would be beneficial to make the skills gain. The teachers-guided activities should be well-planned. Inquiry-based learning is a process in which students develop research questions and create solutions with different methods and discuss. During this process, students are expected to analyze events or phenomena not by through rote learning, but by using critical thinking and scientific process skills actively (Zacharia, 2003). It will be useful to conduct inquiry-based activities to develop such skills. Individual competences and learning levels of the students should be considered in creating the questioning based activities (Kim, 2016). In the case of ignoring the issue, the level of the activities can lead to being quite tough or easy. At this point, the teacher competences appear on the forward. For this reason, the practice-based lesson should be provided to the teacher candidates during university education.

Inquiry-based activities can be developed on different levels based on teacher and student interactions. In the first of these, students use the question and process given by the teacher during a process called a structured inquiry. In the second situation called a guided inquiry, students conduct the process and solution of the question given by the teacher. Another one is called an open inquiry and students form the research question and conduct the process and the solution on their own (NRC, 2000; Sadeh & Zion, 2012; Bayram, 2015). The level of inquiry-based activities can be organized according to students' levels. In all inquiry activities, students need to use the arguments of the nature of science. Using scientific processes comes to the forefront for inquiry-based activities to reach their goal. Inquiry-based learning environments also develop students' scientific process skills and abilities (Wu & Krajcik, 2006; Kaya & Yılmaz, 2016). As a result of the inquiry, an argument covering scientific processes should be used to introduce scientific information (Sarıoğlan & Bayırlı, 2017).

Since the 1950s, scientific process skills have had a place among the basic objectives of science teaching. In science teaching programs which adapt this approach, the goal is for students to use and internalize the scientific process actively (Arı, 2008). Scientific process skills should be stated as basic and integrated scientific skills. The precondition of learning of integrated skills is to gain the basic skills. The facilities aiming at making observations, applying practices and exploring the environment should be created to obtain basic skills. The

activities such as forming assumptions, comment and checking the variables and improving integrated skills should be practiced (Ango, 2002). Making an observation, measuring, making an inference can be classified as the basic scientific skills. Regarding the integrated scientific skills; checking the variables, doing experiments and data-collection can be stated (Chiappetta & Koballa, 2002; Zeidan & Jayosi, 2015). Scientific process skills are of great importance in science teaching.

Students who can actively use scientific process skills can also solve the problems in their lives by using scientific methods. This is one of the most important objectives of science teaching (Çepni & Çil, 2016). Although scientific process skills have a very important place in science teaching, prospective science teachers have quite low performances in conducting these skills and designing activities (Bahtiyar & Can, 2017). It can be seen that prospective teachers believe their scientific process skills can be developed; however, they have insufficient information about how to do this (Yıldırım, Atila, Özmen & Sözbilir, 2013). It will be inevitable for prospective teachers who cannot develop themselves on the issue to have negative reflections of this in their future professional life.

Scientific skills can be developed. In order to develop the scientific creativity of prospective teachers and to make them create scientific arguments, activities which can be applied within the class should be designed (Ayverdi & Aydın, 2017). Lack of scientific process skills will negatively influence prospective teachers' abilities to create arguments. With the development of prospective teachers' cognitive skills, their ability to create arguments will also develop in parallel. Being aware of what knowledge is, the reasons for what is known and the change in conceptual structure is related to argumentation. With argumentation, students learn to find justifications for the thoughts they have, to find out evidence to prove their ideas, to realize the limited aspects of their claims and to respect opposite thoughts by taking part in scientific discussions within the lesson (Demirel, 2016).

Prospective teachers who cannot develop scientific process skills will not have expected levels of interest and curiosity for science. The most frequent problem encountered in science, technology and mathematics education is students' being scared of these subjects. One of the reasons for such fear can be the method of education. The fact that a great number of teachers have not taken courses which teach them authentic scientific research during their undergraduate education causes them not to be able to determine student and teacher roles (Zion, Schanin, & Shmueli, 2013). Prospective teachers have difficulties in creating a problem area which reflects the real world while designing inquiry-based activities. In addition, the thought that they cannot manage the process of inquiry in parallel with the nature of science causes them to get anxious. This situation causes prospective teachers to be discouraged about performing the process (Bayram, 2015). However, on the contrary, especially during undergraduate education, prospective teachers should be educated in a way that they learn how to find a solution to problems within the context of daily life. It will be easier for prospective teachers who can practically create study environments focused on authentic tasks in which science, technology, engineering, and mathematics can be used together to transfer all these to their students in their professional lives in the future. A teacher who has a scientific inquiry and scientific process skills will reflect these on teaching programs and strategies. Thus, prospective teachers should have top-level inquiry-based science skills. A teacher with developed inquiry skills will also have developed scientific process skills. This, in turn, will be a very important opportunity for students (Karışan, Bilican, & Şenler, 2016; Kaya & Yılmaz, 2016; Bedir & Duman, 2017).

1.1. The aim of the study

It seems that inquiry skills are directly related to scientific process skills. A scientific questioning should be a topic to talk provided that questioning should be carried in an appropriate way during the scientific process and the most suitable time is the university education period to improve these kinds of skills. Considering the reasons stated above, questioning based activities have been improved and the use of the scientific process skills of the teacher candidates has been provided. The objective of this study is to research the effect of using inquiry-based activities on the development of scientific process skills of prospective science teachers.

2. Method

2.1. Research design

This study uses mixed research design, in which quantitative and qualitative research methods are used together. Mixed design allows a better explanation, expression and more detailed examination of the relationships between variables (Fraenkel, Wallen & Hyun, 2012). Rather than being a simple mixture of quantitative and qualitative methods, mixed method studies are studies in which strong aspects of these two methods are used together in a way that they support each other (Fırat, Yurdakul, & Ersoy, 2014). The quantitative part of the study uses a quasi-experimental research method, which is one of the experimental research methods given as single group pre-test and post-test. The sample of the study consists of students studying in their third year of science teaching department at Ordu University (n=32). The study continued for a semester (3 months) within the context of "Nature of Science" course. Prospective teachers were grouped into "scientists" of 8 people. During the semester, inquiry-based nature of science activities was given to prospective teachers each week. 36-item scientific process skills scale, which had Cronbach alpha internal consistency coefficient of .70, was given to students as a pre-test in the first class hour and the same test was given to students as post-test at the end of the research.

2.2. Limitations

The study is restricted,
As the study group; Turkey, Ordu University the teacher candidates of Science 3rd class, 2017-2018 Education Year,

As subject area; “the lesson”, “the nature Science and History” questioning based practices and events,

As time period: 90 days, 36 hours.

2.3. Analysis of the data

The scale was assessed out of a score of “100". In the analysis of the data obtained from the pre-test and post-test, SPSS 17 program was used and "t-test for dependent samples" was conducted. In the qualitative part of our study, "content analysis" approach was used. The primary objective of the content analysis is to reach concepts and associations which can explain the data obtained. The primary procedure of content analysis is to bring together similar data within the context of specific concepts and themes and to interpret these (Yıldırım & Şimşek, 2011). While collecting qualitative data, semi-structured interviews and semi-structured observation reports of 8 prospective teachers chosen randomly among the sample were used.

2.4. Activities

Prospective teachers who were grouped into scientists of 8 were assigned their tasks which required one group each week to perform the activity. Before starting the activities, students

were given theoretical knowledge about the nature of science for 6 weeks by the instructor. Prospective teachers who gained enough knowledge about the nature of science started to conduct the activities. The activities which were prepared under the related subject were performed in the classroom, guided by the instructor. The most important rule about performing the activities was the group doing the activity and the other 7 groups thought, discussed and acted like scientists. During the inquiries, examinations and discussions, the principles of the nature of science were applied. Where necessary, the instructor made interventions and guided the groups. The discussions took place within the principles of nature of science. At the end of the lesson, activities were summarized by the instructor and prospective teachers were asked inquiry-based questions and discussions were made.

For the activities assigned to groups, the section named "Activities used for teaching nature of science" in the book "Development and Teaching of Nature of Science" was used (Yenice, 2015). Some additions and deletions were made on these activities and they were used for this study. The activities used in the study are: "Mysterious Lines", "Colourful Boxes", "Competing Theories", "New Society", "Tangram", "Einstein and Eddington", "What's on the side of the cube looking down?", "Periodic Table".

3. Results

3.1. Results of qualitative data

The interviews in this study were conducted with 8 prospective science teachers chosen randomly among the sample. The students who participated in interviews were named as S1, S2, S3, S4, S5, S6, S7 and S8 the qualitative data were analyzed. During the process of creating codes and themes, observation notes of the instructor teaching the course were used in addition to students' interviews. Observation notes were expressed as O1, O2… Content analyses of qualitative data were defined under the themes of "social environment", "cognitive characteristics", "affective characteristics", "effective teaching" and "personal attainments" based on interview codes.

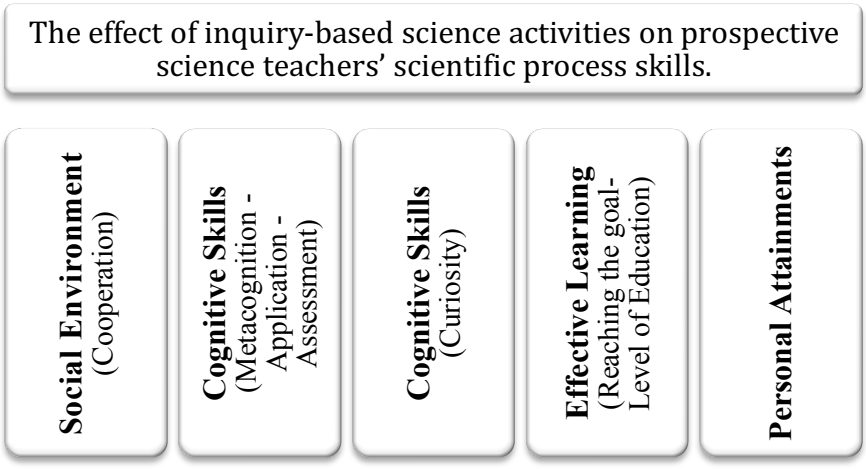

Figure 1. The pattern of the theme developed from interview codes and observation notes

Figure 1 shows the pattern of the themes developed to show the integrative structure of qualitative results.

3.1.1. Social environment

a) Cooperation

While conducting the science activities, prospective teachers mentioned the positive effects of cooperation based group work on their individual learning. They stated that inquiry-based

science activities were much more useful with mutual group interaction. Thus, it is understood that students developed an awareness for the significance of taking into consideration the views of other groups which think differently or which question the scientific explanations of their groups. In addition, it was observed by the researcher that starting from the first week, group members showed more compatible cooperation each week and their self-confidence increased (O1). Views of prospective teachers on cooperation in the development of scientific process skills and observation data are as follows:

"Since the activities were conducted firstly individually and as a group, they gave us permanent learning" (S5).

"We had the chance to try these by commenting on experiment results and making our own hypotheses and since there were many groups, there were similar and different results. Different results proved that science is not unquestionable information." (S4).

"We developed ourselves through brainstorming between groups and within the group. We came a long way between the discussions in the first weeks and the discussions in the last week and this carried us to scientist status. We gained a great deal of self-confidence." (S3).

"It was observed that agreement between prospective teachers within the group was low and this, in turn, decreased the effectiveness of discussions between groups. In the following weeks, the increase in agreement within the group increased the efficiency of the arguments used." (O1).

3.1.2. Cognitive skills

a) Metacognition

Being aware of their own cognitive processes and knowing what they know and what they don't has a very important place in prospective teachers' learning. Prospective teachers stated that it is necessary to use effective learning strategies in a science lesson and that scientific process skills have a great significance at this point. In addition, it can be seen that prospective teachers realized that one of the most important characteristics of scientific teaching skills is interrogative thinking. It is a significant detail that they realize their learning situations and they interpret this learning by associating with their daily lives. This can be concluded as interrogative science activities' being effective in the development of students' metacognitive skills. Prospective teachers' views on their metacognitive skills are as follows:

"Since science lesson is very broad, scientific skills should be very high because subjects are interrelated and one needs to make theorems and hypotheses all the time. And knowledge is changeable. Science lesson is a changeable lesson. Thus, one should follow scientific processes all the time." (S3).

"...before we took the nature and history of science course, we interrogated randomly, that is, we did not realize what we were interrogating." (S4).

"Before I took this course, I had the view that "there is only one knowledge and it should be accepted by everyone without questioning". But, I think different now." (S1)

b) Application

During cognitive processes, prospective teachers are expected to make sense of learning in their minds and to apply this. The mental process of understanding should be completed effectively for the application process to be maintained effectively. It can be understood from prospective teachers' expressions that thinking and acting like a scientist, which is the most important rule of the application process of inquiry-based activities, creates a difference in the development of scientific process skills. In addition, it can be seen that they comprehended the significance of researching the accuracy of events or phenomena based on scientific criteria.

It can be seen that prospective teachers who internalized scientific process skills stated that they wanted to do this with their students in order to increase the efficiency of their lessons in their future professional lives. Positive reflections of inquiry-based activities in the application of knowledge which is made sense of can be understood from the expressions of prospective teachers.

"In this lesson, we tried to think like a scientist, we hypothesized according to the content of the activities." (S5).

"First we interrogated the knowledge, made guesses, hypothesized and tested the accuracy of the knowledge." (S3).

"When I become a teacher, I want to increase the efficiency of the lesson by including my students in what I am doing, like in this lesson." (S1)

"...I test knowledge by looking at specific scientific criteria. I come up with theorems and bring them to a conclusion." (S6)

c) Assessment

In order to be able to make an assessment which requires high-level cognitive skills, meaningful learning should be represented on an application and the process should be analyzed well. In the assessment stage, prospective teachers are expected to make judgments based on scientific criteria. It can be understood from prospective teachers' expressions that they prioritize scientific criteria during the assessment stage. It was stated that in addition to the positive effects of inquiry-based science education on their professional development, it will also be useful for their students. In addition, it can be seen that the process was assessed with a critical approach that using inquiry-based activities in all stages of education can give positive results. Prospective teachers' views on the assessment of the process are given below:

"It allows science teachers to create a communication environment to be included in projects suitable for inquiry-based science education they can use in their lessons and to develop materials and to contribute to their professional development" (S4).

"It is very important for students that a science teacher has high levels of scientific process skills. In experiments conducted with students, I feel that the most important success is achieved by teaching students the sense of interrogation in experiments conducted with students." (S5).

"It could give more positive results if the lesson was taught in all levels of teaching." (S1)

3.1.3. Cognitive skills

a) Curiosity

Curiosity is the most important component of the nature of science. The inquiry, which occurs with curiosity, is expected to take place within the basis of nature of science. At the end of the application process, it can be seen that prospective teachers began to wonder how the process took place before believing in some events or phenomena and that they looked for a cause and effect relationship. It can be seen that being curious leads to interrogation and this, in turn, causes a need for thorough research. It can be understood from prospective teachers' expressions that their needs for interrogation and curiosity increased positively when compared with their previous life.

"I am curious about the backstage of events in the newspapers and books I read. I think about the reasons and consequences." (S1).

"I can look at scientific or normal events around me with a different perspective. I wonder, question, think and research." (S2).

"...We learned how to work up to the solution when there is a problem we are curious about." (S5).

"...I used to look around in a simpler way. Without questioning, without wondering or caring about why things are the way they are." (S6)

3.1.4. Effective Learning

a) Reaching the goal

Methods and strategies used to reach a specified goal play a very important role in students' developing their knowledge and strategies. Using correct methods and strategies in reaching a goal is directly correlated with the attainments students will get. Our study will be more meaningful with the assessment of the process from beginning to end when it is approached as a whole. Prospective teachers who realize their insufficient inquiry skills before taking the course expressed being more conscious at the end of the process. At the same time, it can also be seen that they start to question the events or phenomena by using scientific processes. It can be seen that they emphasize the significance of inquiry and research, which are indispensable for science lessons, on the basis of the nature of science. It can be understood from the prospective teachers' expressions that they have a tendency to believe that they are weak to develop arguments for each event or phenomenon asserted. It is understood that with the help of activities which support the development of their inquiry skills, they realize how to develop arguments for any event or phenomenon. During the application, it was observed that prospective teachers developed themselves continually at the point of assessing themselves and the process (O2). Prospective teachers' views that they expressed during the interviews on the objective and goals of the study are given below:

"Before I took this course, I believed in every piece of news. After I took the course, I examine all the details of the news, make comparisons and measure the reliability of the information." (S3).

"...The biggest example is that I don't believe immediately that a simple news story is true. I use the steps of the scientific process and question the news and decide if it is true." (S4).

"...I think that it did develop, I realized that I don't look at the news with my previous perspective, I consider whether it is interrogative and scientific and make comments." (S5).

"I don't believe immediately any of the news I see on TV. For example, when there is news about ruins from a specific time ago, I question this and try to guess, it wasn't like this before. I believed immediately. Nature of science course contributed a lot to me on this." (S3).

"Nature and history of science course contributed a lot on interrogating, guessing and hypothesizing." (S4).

"While assuming a facilitating and guiding role during the process of learning and teaching, students also began to include interrogation. Students became individuals who research and question the source of information. It developed especially the skills of interrogation, research, and process in science lesson. It enabled inquiring by using the steps of scientific process." (S6)

b) Level of education

In addition to using an effective method and strategy, the level of education is also expected to be suitable for the sample of the study. It can be understood from prospective teachers' expressions that the activities prepared for them were suitable for their level of learning. It was found that prospective teachers who had active roles in activities were able to develop more effective arguments with the guidance of expert instructor when necessary (O3). It was understood that the activities and applications used in the lessons are effective in helping prospective teachers develop arguments including their scientific process skills (O4).

"I think that the paper news we prepared were enough; however, I think that there should be more experiments." (S5).

"The lessons were good. Scientific activities should continue in lessons because since we are the ones doing the activities permanence and the interest in the lesson increases this way." (S4).

"Scientist group work and story analysis suitable for the criterion of being scientific were good activities. There should be more activities about reaching information in parallel with scientific process steps." (S1).

"...The lessons should have more visuals and more discussions." (S3).

"We introduced ourselves as scientists, looked from their perspective and discussed the subjects this way. With this method, knowledge was more permanent." (S6).

"It was much easier to learn with activities. I had more ideas." (S2)

3.1.5. Personal attainments

The most significant effect of inquiry-based science activities on prospective teachers is personal attainments. It is an important attainment to develop oneself and to be able to apply what one has learned in daily life. It can be seen that prospective teachers expressed their self-assessment for their development in a positive way. They expressed that their perspective on an event or a phenomenon became more consistent with curiosity and inquiry. In addition, it can be seen that they learned how they can use scientific process steps in their daily lives and that this situation changed their perspective.

"I approach openly and interrogatively to innovations and this makes information permanent." (S3).

"Previously, I didn't mind if there was a word that I didn't know the meaning of while talking to friends; however, I love to search for things that I don't know about, I make researches on the internet about things that I don't know or about things that I recently learned." (S2).

"I conclude by interrogating many events and by using scientific process steps. Since everything is within science, permanence and perspective change." (S4).

"I don't believe in every news that I see any more, I inquire and I can guess the accuracy rates in my mind." (S6).

"...Of course, it contributed. Questioning science shows that science is important. I comprehended how to question knowledge and at the same time which steps to take to reach knowledge." (S1).

"We learned that there is an inquiry at the beginning of science, I reached correct information by wondering and following scientific process step by step." (S5).

3.2. Results of the quantitative data

The sample group on which the study was conducted was given scientific process skills test as pre-test and post-test and t-test analysis was conducted on the data obtained (Table 1).

Table 1. *Dependent samples t-test results*

		n	x	ss	sh	T-test		
						sd	t	p
Scientific Process Skills	pre-test	32	58,42	3,346	,591	31	4,581	,000*
	post-test	32	70,14	3,992	,706			

*P<0,01

When the pre-test results of the scientific process skills test were examined, the average was found as 58,42 and as 70,14 in the post-test. Dependent samples t-test analysis results show

that inquiry-based activities increase the scientific process skills of prospective science teachers statistically significantly (t=4.581; p<0.01).

4. Conclusion and discussion

The changes in scientific process skills of prospective teachers were measured through the analysis of pre-test data conducted at the beginning of the study and post-test data conducted at the end of the study. SPSS program was used for the analysis of data and dependent samples t-test was conducted. When the dependent samples t-test results were examined, a significant difference was found between prospective teachers' pre-test and post-test data of scientific process skills (t=4.581; p<0.01). From this, it can be concluded that inquiry-based scientific activities are effective in the development of scientific teachers' scientific process skills. It can be seen that the results of our study are in parallel with the results of Karamustafaoğlu and Havuz (2016)'s study that research-inquiry based activities increase prospective teachers' science teaching skills. In addition, it can be seen that the results of the study are in parallel with the results of studies which report that inquiry-based science teaching has a significantly positive effect on the development of scientific process skills (Karışan, Bilican, & Şenler, 2016; Kaya & Yılmaz, 2016; Bedir & Duman, 2017).

In order to make a detailed explanation about how and why this difference occurred, data of the interview conducted with prospective teachers and observation data of the researcher were analyzed in detail. Content analysis was conducted on the qualitative data obtained. The codes obtained from interview data were defined under the themes of "social environment", "cognitive characteristics", "affective characteristics", "effective teaching" and "personal attainments".

When the effects of inquiry-based scientific activities on the "social environment" within the class were examined, groups works based on cooperation can be seen to come to the forefront. It is expressed by prospective teachers that activities performed during the class allow for such cooperative learning and also useful shares between groups and within groups. Students' structuring and interpreting information are influenced by social and cultural factors as much as physical and personal factors. In order to make the learning of prospective teachers' meaningful, social and cultural environment should be taken into consideration (Stears & Gopal, 2010). Vygotsky's theory that development takes place from society to the individual (Vygotsky, Hanfmann & Vakar, 2012) is influential in this sense. Social environments are important opportunities to learn. In this study, it can be said that the social environments created are effective in prospective teachers' learning. It can be said that the social settings created in this study were effective on the development of prospective teachers' scientific process skills. It is thought that conducting research-inquiry based activities with group work is effective in the development of prospective teachers' problem-solving skills (Karamustafaoğlu & Havuz, 2016). Cooperative learning environments motivate cooperation, sharing, acting together, encouraging each other and learning. In cooperative learning environments, it can be said that prospective teachers help each other to learn and develop their social skills by working together to succeed in a common purpose (Arslan & Zengin, 2016)

It was found that teachers' lack of knowledge about how they can apply scientific processes in lesson subjects and in daily life has a negative influence on their practices. Undergraduate field courses should have an applied form of teaching. In these courses, prospective teachers should be taught the significance of the subject in daily life, where and how the knowledge and the skills gained will be used, concrete examples and associations by using scientific process skills (Tatar & Ceyhan, 2018). Prospective teachers' expressions under the theme of "cognitive characteristics" were examined under the titles of "metacognition, application, and assessment". It can be understood from prospective teachers' expressions that as their inquiry

skills develop and their scientific process skills also develop. It can also be seen that prospective teachers who are aware of their scientific processes are also successful in the stage of applying what they learn. At the same time, it can be seen that they are eager to transfer this skill they develop to their students in their future professional lives. It can be seen that prospective teachers who apply the scientific process skills they develop through inquiry-based activities keep their scientific process skills in the foreground while assessing the process. This shows that prospective teachers could develop their cognitive skills. In order for science teachers to develop their students' cognitive skills, they should have gained this information and skill in the first place (Aydın & Yılmaz, 2010). When teachers who have these skills create lesson environments which focus on students' cognitive development, important opportunities will show up in the development of students' cognitive skills (Kurnaz & Kutlu, 2016).

In their study, Tatar and Ceyhan (2018) found that prospective teachers ignored the skills, attitudes and values dimensions of attainments by focusing on only the information dimension while planning lessons. This study shows that prospective teachers do not have much information about cognitive skills. In addition to the development of prospective teachers' cognitive skills, the development of their affective skills is also very important. It can be understood from the results of the study conducted that very important attainments were created about "curiosity" which is very important for the development of prospective teachers' scientific process skills development. Curiosity is one of the most important steps of scientific process skills. Scientific process skills are indispensable for science. Science teachers who are curious, interrogative and who make researches are an important opportunity for their students. There is a positive correlation between curiosity and science subjects (Ceylan, Sağırekmekçi, Tatar & Bilgin, 2015; Harty, Beall & Scharmann, 1985).

For the development process of prospective teachers' scientific process skills, teaching should be conducted in an effective way. Under the theme of "effective teaching" teaching activities' reaching their aim and the level of education have an important place. It can be seen from prospective teachers' expressions that their inquiry skills were poor before the lesson started; however, as time went by, they developed this skill with the help of inquiry-based activities. Prospective teachers need developed inquiry skills to make accurate arguments. These kinds of skills can be developed through the use of correct methods and strategies in correct teaching level. Teaching environments and plans should be designed to develop students' thinking skills (Aydın & Yılmaz, 2010). It can be said with reference to prospective teachers' expressions that the study reached its objective in terms of this aspect. It can be concluded that by creating teaching environments which will enable more applied research-inquiry based science teaching, prospective teachers' self-sufficiency beliefs will also be increased (Kocakülah & Turan, 2017). Scientific skills can be developed and in order to develop the scientific creativity of students, activities which can be applied within class should be designed (Ayverdi & Aydın, 2017). Teachers' competence comes to the forefront in the design and application of such activities. In their study, Tatar and Ceyhan (2018) reported that prospective teachers had difficulties in planning and applying activities based on student-centered methods and techniques. It can be understood from prospective teachers' statements that the teaching environment created in our study had an influence on developing their scientific process skills. It can be said that the difficulties experienced by prospective teachers who have developed scientific process skills can be minimized in designing and applying student-centered activities.

When this study is discussed in terms of personal attainments, it can be seen that prospective teachers stated that the study contributed a lot to the development of their inquiry and scientific process skills. It can be seen that they stated having learned to use scientific process skills while evaluating the events or phenomena within daily life. In the teaching of prospective teachers,

it is very important to include activities to develop learning skills, self-sufficiency and personal attainment (Deveci & Çepni, 2014). It is understood from the expressions of prospective teachers in the interview that this study contributed to their personal development.

5. Recommendations

The most important factor in the development of scientific process skills is inquiry skills. Since research-inquiry based teaching also develops critical thinking skills, it will contribute to the development of students' skills about science subjects. Science teachers should be educated on the basis of the nature of science and they should make this a part of their lives. Inquiry-based science activities play an important role in the development of such activities. It is recommended for researchers that the content of lessons taught in the departments educating science teachers should include more inquiry-based science activities.

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