Universal Journal of Educational Research 4(3): 603-612, 2016 http://www.hrpub.org
DOI: 10.13189/ujer.2016.040319

The Impact of Inquiry Based Instruction on Science Process Skills and Self-efficacy Perceptions of Pre-service Science Teachers at a University Level Biology Laboratory

Ceylan ŞEN, Gülşah SEZEN VEKLİ*

Department of Elementary Science Education, Bozok University, Turkey

Abstract The aim of this study is to determine the influence of inquiry-based teaching approach on pre-service science teachers' laboratory self-efficacy perceptions and scientific process skills. The quasi experimental model with pre-test-post-test control group design was used as an experimental design in this research. The sample of this study included 24 pre-service science teachers. Data were collected using Laboratory Self-Efficacy Scale, The Test of Integrated Process Skills and Interview Form. According to results, the positive influences of inquiry-based teaching approach on pre-service science teachers' laboratory self-efficacy perceptions and scientific process skills have been observed. Participants determined positive thinking to positive effectiveness of inquiry-based teaching approach in interviews.

Keywords Inquiry Based Instruction, Pre-service Science Teachers, Self-efficacy Perception, Scientific Process Skills

1. Introduction

In many science curricula developed recent years, it has been underlined that acquisition of the scientific process skills should be one of the major goals of science instruction. It is specified that teachers and pre-service science teachers are aware about scientific processes but they are insufficient in terms of their applications [1]. The fact that pre-service science teachers did not have sufficient and effective application-oriented education is specified as one of the reasons for this in the studies [2], [3], [4], [5], [6]. For this reason, firstly pre-service science teachers are expected to have scientific process skills and it is necessary for them to have vocational education with effective applications to acquire such skills [7].

Results of several studies have shown that students' scientific process skills can be developed by using inquiry or investigative approach of teaching and learning science that gives them opportunities to practice these skills [8], [9], [10], [11]. Inquiry based instruction is a teaching strategy that aims to develop students' skills to deal with problems that they may encounter by using the methods used by scientists via researching, investigating, analyzing and inquiring in the classroom [12]. There are studies that investigate the effects of inquiry-based learning environments almost all grade students' understanding [8], [9], [10], [11] scientific process skills [8], [13], [14], [15], [16] and provides motivation and positive attitude towards science and science [14], [17], [18], [19], [20]. However, there is limited research on how pre-service science teacher learn to teach inquiry based instruction on biology issues, especially in the context of practical work. This gap has driven the empirical study presented in the rest of this paper.

On the other hand self-efficacy perceptions of the pre-service teachers are among the most important factors in an innovative teaching method such as inquiry based instruction [21], [22] due to the fact that students ask questions, make observations, conduct researches and hypothesize during the inquiry process. They test the hypotheses they have developed and make guesses regarding the possible results [23]. Longo [24] conducted an experimental study to determine the effect of inquiry based instruction and specified that students learning in laboratory environments where research and inquiry based activities are done had better self-efficacy perceptions compared to the students learning with traditional approaches. However limited research has explored the development of pre-service science teacher self-efficacy formed during enrolment in teacher education programs.

The goal of the study is to determine the impact of inquiry based instruction on pre-service science teachers on the

laboratory usage, self-efficacy perception and scientific process skills of these pre-service science teachers. The main contribution of this paper to the literature relates how the inquiry based instruction influences pre-service science teachers' scientific process skills and self-efficacy perceptions at a university level biology laboratory. In this study, answers for the following questions were researched:

1. Is there a significant difference between the scores that pre-service science teachers in the experimental group participating in Inquiry based instruction got from Pre-Scientific Process Skills Test and Post-Scientific Process Skills Test?
2. Is there a significant difference between the scores that pre-service science teachers in the control group, who were taught with the traditional approach, got from Pre-Scientific Process Skills Test and Post-Scientific Process Skills Test?
3. Is there a significant difference between the pre-service science teachers in the experimental group participating in Inquiry based instruction and the pre-service science teachers in the control group, who were taught with traditional approach, in terms of the post-test scores they got from "Scientific Process Skills Test"?
4. Is there a significant difference between the scores that pre-service science teachers in the experimental group participating in Inquiry based instruction got from Pre- Laboratory Usage Self-efficacy Perception Scale and Post Laboratory Usage Self-efficacy Perception Scale?
5. Is there a significant difference between the scores that pre-service science teachers in the control group on who were taught with traditional approach, got from Pre- Laboratory Usage Self-efficacy Perception Scale and Post Laboratory Usage Self-efficacy Perception Scale?
6. Is there a significant difference between the pre-service science teachers in the experimental group participating in Inquiry based instruction and the pre-service science teachers in the control group, who were taught with traditional approach, in terms of the post-test scores they got from "Laboratory Usage Self-efficacy Perception Scale"?
7. What are the thoughts of science pre-service science teachers in the experimental group participating in Inquiry based instruction about Inquiry based instruction approach after the application?

2. Method

Research Design

The purpose of the study is to investigate the laboratory usage self-efficacy perception and the development of other scientific process skills of the pre-service science teachers participating in Inquiry based instruction such as problem posing, hypothesizing, determining the variants and the ability to design experiments. For these purposes, a quasi-experimental model with pretest and post-test control group was used in the study [25].

Study Group

The study was conducted with the participation of 24 second grade pre-service science teachers, 15 (62%) of whom were female and 9 (38%) of whom were male) who have been studying in the Department of Primary School Science Teacher Education of a public university.

Table 1. Distribution of experimental and control group's gender

Group	Gender				Total	
	Female		Male			
Experimental	9	%60	3	%33.3	12	%50
Control	6	%40	6	%66.7	12	%50
Total	15	%100	9	%100	24	%100

Method of Procedure

Multiple-subject pretest and post-test quasi-experimental design [25] was used in the study and it was conducted in General Biology Laboratory - I course given during the fall semester of 2014-2015 educational year. General Biology Laboratory is a course with 4 hours of application in a week.

24 pre-service science teachers in the study were chosen by means of criteria sampling [25] which are a non-random purposeful sampling method. Special attention was paid for the pre-service science teachers who will choose General Biology Laboratory - I to be people with a grade score average between 2.00 and 3.00. Students with odd numbers were determined as the experimental group while students with even numbers were determined as the control groups after the students' lists were prepared.

The content of the application was shaped according to the subjects in the syllabus of General Biology Laboratory-I course and 14 weeks long experiments were applied. Two different work sheets were prepared for the pre-service science teachers in the experimental group and the control group.

Implementation Process for Experimental Group

Experiment sheets prepared for the pre-service science teachers in the experimental group are comprised of three parts: (a) giving an example for a problem and designing experiments for this, theoretical knowledge in the experiments, purpose, problem and related estimations, (b) detailed expression and the result of the designed experiment, (c) self-assessment of the studies.

An exemplary lecture was applied by one of the researcher. During this process inquiry based teaching was conducted on subject of "Investigating Cell Division" for the experimental group sheets includes the following problem "Mehmet's mother stored food in bulk in their house for winter. Potatoes, onions etc. After a while, she saw that bums started to form

on some of the potatoes. Explain the reason of this and design an experiment that can be an example for the situation". Pre-service science teachers will go through the theoretical knowledge section and the following steps before coming to teach the subject:

- Write down the problem situations you have determined in the scenario you read.
- Design experiments to find answers for your questions.

The application made in the laboratory, on the other hand, includes the steps of the procedure regarding the designed experiment.

- Research problem,
- Observation,
- Estimation,
- Purpose of the experiment,
- Design of the experiment
- Describe the experiment you did in detail (specify the results of the observation and the measurement, you can tabulate your measurement results),
- Result.

The section in which pre-service science teachers can assess their works after the experiments include the following items:

- What did I do during this activity?
- What did I learn during this activity?
- Things I did during this activity
- Things I found most difficult during this activity
- What kind of unexpected things I have encountered during my work?
- I would do this like that if I were to conduct this study again.

Implementation Process for Control Group

"General Biology Laboratory Guide" prepared by Arslan, Bahar and Özel [26] to conduct additional experiments to the ones in the experiment sheet prepared for the control group was used. Experiment sheets of the control group include purpose of the experiment, theoretical knowledge, conduct of the experiment and the result sections.

The application of the same experiment on the control group includes reading before the lecture the experiment "4.5. Investigating the Cell Divisions" in the book "General Biology Laboratory Guide" prepared by Arslan, Bahar and Özel [26] and "The Purpose of the Experiment" and "Theoretical Knowledge" sections in the sheets. The experiment was finalized by completing "Materials that are used" and "The Results of the Experiment" sections after applying the experiment. The study was carried on by giving the pre-service science teachers in the experiment and the control groups the feedback they needed during the process. The pre-service science teachers participated in the lecture period with experiments they prepared for biology subjects each week.

Explanations and information regarding the teaching method used during the lecture were presented before the first lecture. Necessary explanations were made regarding the things that pre-service science teachers should do and the prepared laboratory sheets. Explanations regarding applications made during the lecture and lecture curriculum were made and students of the experiment and the control groups were given laboratory sheets they will use within the scope of their own lectures. Pretest administration was made before the first lecture in the study. Posttest was administrated after the final examinations. The tests were taken approximately between 20 and 30 minutes. On the other hand, qualitative data was collected via interview, two days after the posttest administration.

Collection of Research Data

Collecting Research Data. Research data was obtained by using qualitative and quantitative data collecting methods together. Laboratory Usage Self-efficacy Perception Scale developed by Ekici [21] and Scientific Process Skills Test adapted to Turkish by Özkan, Aşkar and Geban [27] were used as qualitative data collecting tools during the study. Interview Form was used as a qualitative data collecting tool to support the qualitative data.

Quantitative Data Collecting Tools. Laboratory Usage Self-efficacy Perception Scale and Scientific Process Skills Test are the quantitative data collecting tools in the study.

Laboratory Usage Self-efficacy Perception Scale (LUSPS): Laboratory usage self-efficacy perception scale developed by Ekici [21] was used to determine the self-efficacy of preservice science teachers regarding laboratory usage. The scale has 18 items. These items are divided into two dimensions while 8 of them (6, 10, 2, 15, 7, 12, 14, 5) are personal factors and 10 of them are (3, 9, 16, 11, 13, 17, 1, 18, 8, 4) external factors (factors resulting from the environment). The Cronbach's alpha reliability coefficient of the personal factors dimension was calculated as 0.90 while the Cronbach's alpha coefficient of the external factors dimension was calculated as 0.85. Laboratory usage self-efficacy perception scale is a five score likert type scale varying between "I absolutely do not agree, I do not agree, I am undecided, I agree and I absolutely agree". Cronbach's alpha reliability coefficient was determined as 0.87 for the laboratory usage self-efficacy perception scale during this study.

Scientific Process Skills Test (SPST): Scientific process skills test, the original name of which is “The Test of Integrated Process Skills II (TIPS II)’’ which was developed by Burns, Okey and Wise (1985), was applied to the pre-service science teachers in the experiment and control groups as the pretest and post-test. Cronbach's alpha reliability coefficient of the test is 0.86. Turkish adaptation of scientific process skills test made by Özkan, Aşkar and Geban [27] was used in this study. The test is formed of 36 multiple-choice questions and includes five scientific process skills; (a) determining and checking variables (12), (b) defining by doing (6), (c) hypothesizing (9), (d) data analysis and drawing graphs (6) and (e) making experiments (3). The scores obtained from the test range between 0 and 36

as 1 test-takers received 1 for each true answer in the test and zero for incorrect or unanswered questions. Scientific process skill test's Cronbach's Alpha reliability coefficient was determined as 0.92 for this study.

Qualitative Data Collection Tools. Semi-structured interview technique was used to collect qualitative data in the study. Semi-structured interviews were made with 12 pre-service science teachers in the experimental group in which Inquiry based instruction approach was applied. Thus, it was aimed to determine positive/negative thoughts of teach candidates of the experimental group in which Inquiry based instruction approach was applied, regarding the method.

Interviews were made separately with the pre-service science teachers in the experimental group and they were recorded by means of a tape recorder. The study room of the researcher was used as an interview room to be able to understand the sounds comfortably during the interviews. Interviews were made out of the course hours so that they would not be interrupted.

Analysis of Research Data

Analysis of Qualitative Data. SPSS 16.0 package was used while analyzing the data obtained from the tests. Non-parametric tests, Mann-Whitney U Test and Wilcoxon Signed Rank Test were used to determine the relations between the scores of the groups. A significance level of at least 0.05 was sought in the statistical procedures.

Analysis of Qualitative Data. Qualitative data was collected by means of semi-structured interview technique. Interviews were made with the participation of 12 participants from the experimental group. Interviews were made after the application of posttest following the 14 weeks long study. It is specified in the descriptive analysis approach of Yıldırım and Şimşek [28] that the data can be considered and presented according to the questions discussed during the interview. Interviews made with the preservice science teachers in the experimental group was coded as K1, K2, ... K12 and positive/negative thoughts regarding Inquiry based instruction was discussed in terms of the contribution of the teaching method to the laboratory applications. This data was classified and the cause and effect relationships were investigated and interpreted [28];

Preparing the interview questions. Semi-structured interview form prepared and its final form was given after having it investigated so as to provide its internal and external reliability. Interviews in the form of sound recordings were decoded as text by making pilot applications with representative students and it was controlled by three experts whether the questions were clear and understandable and they include the subject. Interview form took its final shape after the pre-application and was used to interview the experimental group pre-service science teachers participating in the study.

Breakdown of the interviews. Interviews were made with 12 pre-service science teachers in the experimental group in the 15th week of the study after completing the Inquiry based instruction application. Interviews were recorded by means of a tape recorder and they were decoded to the computer as Word documents and that were analyzed by the researcher. Interviews were recorded as different files for each participant. For their approval the documents were presented to the pre-service science teachers in the experimental group with whom the interviews were carried out, and it was checked whether there were any misunderstandings. Breakdowns were checked by three experts not to cause any deficiencies or faults.

Preparing interview coding key. Interview documents were transferred to "Nvivo Qualitative Data Analysis Program" and sub-themes and categories were created. Interviews were discussed in relation with the themes of positive and negative thoughts regarding Inquiry based instruction and the contribution of this teaching method on the laboratory applications.

Reliability of the study. Firstly, a pilot study was conducted and adjustments were made by getting the opinion of an expert after this application in order to ensure the reliability of the study. Interviews turned into written form were checked by experts and personally by the participants with whom the interviews were made in order to ensure that there were no deficiencies or faults.

3. Findings

Data obtained as a result of the statistical analyses regarding the scores that the preservice science teachers in the experimental group, who participated in research and inquiry based teaching, and the pre-service science teachers in the control group in which the traditional approach was applied, got from "Scientific Process Skills Test" and "Laboratory Usage Self-efficacy Perception Scale", which were applied on them as a pretest and post-test, are presented. Qualitative data obtained using interview form to support the quantitative data is presented.

Data obtained as a result of Mann-Whitney U test and Wilcoxon Signed Ranked test, which were applied to determine the effect of Inquiry based instruction approach of the primary education science pre-service science teachers on the laboratory usage self-efficacy perception and scientific process skills are given.

Pretest scores that pre-service science teachers in the experimental and control groups got from the SPST test before the procedure was compared using Mann-Whitney U test. The results of the analysis are given in Table 2.

Table 2. Mann Whitney U Test Results for Experimental and Control Group's Pretest SPST

Group	N	Mean Rank	Sum of Ranks	U	p
Experimental	12	13.46	161.50	60.50	.503
Control	12	11.54	138.50		

When findings in Table 2 are taken into consideration (U=60.50, p>.05) it is seen that two groups did not have significant differences before the experimental procedure. This indicates that the pre-service science teachers in the experiment and the control groups were equal to each other in terms of scientific process skills before the experimental procedure.

Scores that the pre-service science teachers in the experimental group, who participated in research and inquiry based teaching, got from SPST test (pretest - post-test) were compared with Wilcoxon Signed Rank Test.

Table 3. Wilcoxon Signed Ranks Test Results for Experimental Group's SPST test (pretest - post-test)

Pretest-Post test	n	Mean Rank	Sum of Ranks	Z	p
Negative Ranks	0	.00	.00	-3.066	.002
Positive Ranks	12	6.50	78.00		
Ties	0				
Total	12				

It is seen in Table 3 that there are significant differences between pretest and post-test scores of the preservice science teachers in the experimental group and this difference is in favor of the post-test scores (p= .002< .05).

The scores that the pre-service science teachers in the control group, where traditional teaching approach was applied, got from SPST test (pretest - post-test) are compared using Wilcoxon Signed Rank Test.

Table 4. Wilcoxon Signed Ranks Test Results for Control Group's SPST test (pretest - post-test)

Pretest-Post test	n	Mean Rank	Sum of Ranks	Z	p
Negative Ranks	0	.00	.00	-2.955	.003
Positive Ranks	11	6.00	66.00		
Ties	1				
Total	12				

It is seen in Table 4 that there are significant differences between pretest and post-test scores of the preservice science teachers in the control group and this difference is in favor of the post-test scores (p= .003< .05).

The post-test scores that the pre-service science teachers in the experimental group, who participated in research and inquiry based teaching, and the pre-service science teachers in the control group, where traditional teaching approach was applied, got from the SPST test were compared using Mann-Whitney U test.

Table 5. Mann Whitney U Test Results for Experimental and Control Group's Post-test SPST

Group	N	Mean Rank	Sum of Ranks	U	p
Experimental	12	24.96	155.50	66.50	.020
Control	12	12.04	122.50		

As it is seen in Table 5, the mean rank of SPST post-test scores was determined as 24.96 for the pre-service science teachers in the experimental group while it was determined as 12.04 for the pre-service science teachers in the control group. This result indicates that there is a significant difference between the SPST post-test scores of the experimental group and the control group in favor of the experimental group (U=66.50, p=.020< .05).

Pretest scores that pre-service science teachers in the experimental and control groups got from the LUSPS scale before the procedure was compared to Mann-Whitney U test. The results of the analysis are given in Table 5.

Table 6. Mann Whitney U Test Results for Experimental and Control Group's Pretest LUSPS

Group	N	Mean Rank	Sum of Ranks	U	p
Experimental	12	14.17	170	52.00	.246
Control	12	10.83	130		

When findings in Table 6 are taken into consideration (U=52.00, p=>.05) it can be said that two groups did not have significant differences before the experimental procedure. This indicates that the pre-service science teachers in the experiment and the control groups were equal to each other in terms of laboratory usage self-efficacy before the experimental procedure.

The scores that the pre-service science teachers in the experimental group, who participated in research and inquiry based teaching, got from LUSPS scale (pretest - post-test) were compared using Wilcoxon Signed Rank Test.

Table 7. Wilcoxon Signed Ranks Test Results for Experimental Group's LUSPS test (pretest - post-test)

Pretest-Post test	n	Mean Rank	Sum of Ranks	Z	p
Negative Ranks	0	.00	.00	-3.068	.002
Positive Ranks	12	6.50	78.00		
Ties	0				
Total	12				

It is seen in Table 7 that there are significant differences between LUSPS pretest and post-test scores of the pre-service science teachers in the experimental group and this difference was in favor of the post-test scores (p= .002< .05).

The scores that the pre-service science teachers in the control group, where traditional teaching approach was applied, got from LUSPS scale test (pretest - post-test) are compared using Wilcoxon Signed Rank Test.

Table 8. Wilcoxon Signed Ranks Test Results for Control Group's LUSPS test (pretest - post-test)

Pretest-Post test	n	Mean Rank	Sum of Ranks	Z	p
Negative Ranks	0	.00	.00	-3.072	.002
Positive Ranks	12	6.50	78.00		
Ties	0				
Total	12				

It is seen in Table 8 that there were significant differences between pretest and post-test scores of the pre-service science teachers in the control group and this difference is in favor of the post-test scores (p= .002< .05).

Post-test scores that the pre-service science teachers in the experimental group, who participated in research and inquiry based teaching, and the pre-service science teachers in the control group, where traditional teaching approach was applied, got from the LUSPS scale were compared using Mann-Whitney U test.

Table 9. Mann Whitney U Test Results for Experimental and Control Group's Post-test LUSPS

Group	N	Mean Rank	Sum of Ranks	U	p
Experimental	12	22.45	550.00	34.50	.000
Control	12	16.82	220.50		

As it is seen in Table 9, the mean rank of LUSPS post-test scores was determined as 22.45 for the pre-service science teachers in the experimental group while it was determined as 16.82 for the pre-service science teachers in the control group. This result indicates that there is a significant difference between the LUSPS post-test scores of the experimental group and the control group in favor of the experimental group (U=34.50, p=.000< .05).

Findings Drawn from the Opinions of Pre-service Science Teachers Regarding Research and Inquiry Based Teaching

Positive thoughts regarding the applications of Inquiry based instruction approach on the laboratory lectures include the opinions suggesting that the lectures were more fun, preservice science teachers were more active and they were inclined to make more research. The opinion of teacher candidate K1 regarding this positive effect is as follows:

> *"We give more time to researches when we are making experiments in the laboratory this way. First we make research on our own and then we share the information we find with our friends. Thus, we find the opportunity to work with our friends. We learn about different experiments that can be done about the subject by sharing ideas about the experiments we guessed."*
> *"We learn the subjects by writing and doing something. I think it is more permanent as we fill the sheets before, during and after the experiment (K2)."*

They had chances to compare the theoretical information obtained as a result of the researches made before the experiments and the results the pre-service science teachers obtained by designing their own experiments. Thus, they found the ways of accessing information by means of inquiry on their own. Opinions of the participants about the subject are as follows:

> *"Experiments we will make in the laboratory were not given readily available. We researched and thought on our own and compared what we thought. Thus, we had a chance to work as a group and it was fun. I did not directly write the results I obtained. I compared them with my friends' results. It made me realize there were different solutions to gain the right result (K3)."*
> *"I learned how to do research. I have seen better how I will find what I need to find. I learned how to question and interpret the information I obtained. I interpreted the results of my own experiment with the theoretical information in the resources in the conclusion section of the experiment. I sometimes encountered inconsistent information. I decided what was right by comparing the results I obtained from the experiments I have made and with those of my friends obtained from their experiments (K5)."*
> *"We understand where we make mistakes by comparing the results of experiments because of designing our experiments ourselves. I learned more permanently and quickly since we did it in the right way in practice. I learned whether or not the information written in the books was right by testing it on my own (K6)."*
> *"We reach theoretical information by making literature searches before doing the experiment. I am making comparisons when I do an experiment and obtain my own result. Thus, I learn how I can access the accurate information by testing it on my own (K11)."*

Participant K9's opinion regarding pre-service science teachers designing their own experiments instead of being given prepared directives of how to do experiments is as follows:

> *"We did not do the experiments whose instructions had been given. I think it had a positive effect on my learning because I researched and designed on my own. I learned many experiments that I will be able to do with my students when I become a teacher."*

When the difficulties encountered in the application of Inquiry based instruction approach are taken into consideration, it is seen that pre-service science teachers have negative opinions about this method because of its time-consuming nature and the challenge it brings about for accessing reliable resources.

> *"I hesitate whether or not we accessed accurate information when we scanned the literature about the subjects of the problems in the sheets (K1)."*
> *"Sometimes the information I accessed during the experiment and the information in the resources were not consistent. I had problems while accessing the right*

resource (K2).”

"Before, during and after the experiment, we always filled our sheets by making research and it was very tiring and time-consuming (K3)."

"We are researching and investigating too much. It takes our time and we are getting tired (K4)."

"...I had to prepare and do another experiment again when some experiments I guessed and had done did didn’t yield me accurate results. It was time-consuming (K8).”

There are some participants’ opinions with regard to the application of General Biology Laboratory - I lecture with Inquiry based instruction approach suggesting especially theoretical information was understood better and permanent learning occurred:

"We understand the subject more easily since we research, design and do the experiment on our own. We realize our mistakes since we do the application on our own. Thus, we do experiments more consciously since we research on our own. I remember better while studying for the exam (K1)."

"I learned better when we thought about and designed our experiments on our own. There were no ready steps to do experiments and we thought and prepared everything (K4)."

Opinions of the participants who stated that they gained skills regarding laboratory applications are as follows:

"We designed and tried to apply the experiments ourselves. Sometimes we could not obtain any results when we tried the experiment we guessed. We tried other alternatives. Thus, I understood where we made mistakes. I think my handcraft for the materials I used in the laboratory improved (K2)."

Participants' opinions with regard to learning theoretical information more permanently and effectively during General Biology lecture are as follows:

"I gained skills regarding applications in the laboratory. I realized the situation of the biology subjects in daily life since the problems in the sheets were the problems of daily life. I ensured that my knowledge would be permanent as I learned by doing and researching myself. I do not forget about the reasons for the results of the experiments I did, I can easily remember them. This should be applied to other with other subjects because they are all learnt theoretically and based on memorization (K3)."

"We encounter lots of theoretical information in General Biology course and now, thanks to this application, we have actually seen the examples of this theoretical information in real life. I have developed some positive thoughts regarding biology lecture (K5)."

"We also reinforced what we had learned during General Biology lecture because of the fact that we had researched about the theoretical information before the lecture. We learn the subjects more comfortably and enjoyably. It would not have been enjoyable if we only had learned the subjects in the General Biology lecture or we had only prepared experiments in the laboratory. The lecture was more fun because since I designed my own experiment."

"Biology subjects are too much based on rote learning. So, it becomes difficult to learn them. We research about the subjects in advance and design the experiments on our own since the laboratory applications require researches. Thus, we learn this subject by practicing in real time (K10).

4. Discussion and Conclusions

Inquiry based instruction aims at making students experience the researching process of a scientist [29]. In this study, different problem situations are given to the experimental group, where Inquiry based instruction approach was applied and they were asked to determine research questions, hypothesize and obtain results by designing experiments. In addition to developing scientific process skills of the pre-service science teachers, the treatment aimed to make positive contribution to self-efficacy perception levels of them considering their laboratory usage.

It is seen that there is no significant differences between the scores pre-service science teachers in the experimental group who participated in research and inquiry based teaching and the pre-service science teachers in the control group where traditional teaching approach was applied obtained from the SPST test. This indicates that the pre-service science teachers in the experiment and the control group were equal to each other in terms of scientific process skills before the experimental procedure.

It is seen that there is a statistically significant difference between the SPST test scores of the pre-service science teachers in the experimental group where Inquiry based instruction approach was applied got before and after the application During the interviews made with the pre-service science teachers after the application, it was seen that they also realized this improvement. It can be asserted that activities based on Inquiry based instruction contributed the improvement in SPST scores that participant pre-service science teachers got. SPST score average of the pre-service science teachers in the control group where traditional approach was applied was 11.54 while their test score average increased to 12.04 after the application. It is considered that observing and making conclusions during the experiments may have positive effects on the pre-service science teachers in the control group where traditional approach was used. When SPST pretest and post-test scores of the experimental group are compared, it is seen that pretest mean scores are lower than the mean scores that can

be obtained in the test (N=13.46<18). On the other hand, it is observed that the post-test SPST scores of the pre-service science teachers are above mean (N=24.96>18). Sadeh and Zion [30] observed in their study that the scientific process skill mean scores of the preservice science teachers improved in research and inquiry environment. Similarly, Champbell, Zhang and Neilson [31] stated that the scientific consideration skills of the preservice science teachers developed positively during the period of their study. Akerson et al. [32] who stated that the Inquiry based instruction had positive effects, underlined the importance of approaches regarding scientific process skills and the nature of the science rather than approaches in which only the knowledge is transferred. In some studies, it was concluded that scientific process skills cannot be acquired by means of research and inquiry-based teaching approach [33]. It is claimed that this was because some skills were not appropriate for the level of the students and students were not able to learn all the skills at once [33]. Wilke and Straits [33] stated that a teaching approach which includes concepts in research and inquiry process would be more effective in terms of giving students scientific process skills.

It is understood from the interviews made with the pre-service science teachers that researching and inquiry ensured permanent learning and students did not receive the information readily in this way. It is seen that they are making comparisons, in other words, inquiry by comparing the theoretical information in many resources and the results they reached are as results of the experiments they did. These results support the conclusion suggesting that Inquiry based instruction approach had positive effects on the meaningful learning of the pre-service science teachers. During their study in which they determined the opinions of pre-service science teachers regarding Inquiry based instruction approach, Windschitl, Thompson and Braaten [34] stated that the pre-service science teachers recognized the importance of the teaching approach after the approach had been applied and considered the application positive.

It is stated by the teachers that environments in which opportunities were created for pre-service science teachers to work in cooperation and exchange ideas are formed. Hatton and Scholer [35] stated in their study that students were more active and exchanged information with each other in a more interactive way when Inquiry based instruction was used.

Negative opinions regarding the reaching approach based on research and inquiry include that the application was very time-consuming and tiring. Brown et al. [3] stated in their studies that Inquiry based instruction method had a time problem in terms of inquiry. Regarding this approach, some teachers have the perception that this application can be possible mostly with successful students [2]. It is seen that teachers do not have positive opinion with regard to using this method in laboratory applications as they think Inquiry based instruction is a time-consuming method [3].

It is seen that there are no significant differences between the scores pre-service science teachers in the experimental group who participated in research and inquiry based teaching and the pre-service science teachers in the control group in which traditional teaching approach was applied obtained from the LUSPS scale. This indicates that the pre-service science teachers in the experiment and the control groups were equal to each other in terms of laboratory usage self-efficacy before the experimental procedure.

It is seen that there is a statistically significant difference between the scores the pre-service science teachers in the experimental group in which Inquiry based instruction approach was applied got on the LUSPS scale before and after the application. Means scores of the pre-service science teachers in the control group in which the traditional approach was applied on the LUSPS scale was 10.83 while their mean scores on the same test increased to 16.82 after the application. It is seen that LUSPS scale pretest mean score of the pre-service science teachers in the experimental group in which Inquiry based instruction approach was applied was 14.17 and the post-test mean score increased to 22.45 after the application. This statistical result indicates that Inquiry based instruction had a positive effect on laboratory usage. In research and inquiry based teaching, students make research and decide about the experiments they plan to do before starting to do the experiments. It was understood from the interviews made with pre-service science teachers that they felt themselves more competent in terms of doing experiments because they designed their experiments on their own. They state that they had the self-efficacy to design a different experiment when they got a false result.

It is understood that Inquiry based instruction approach led to improvement in terms of laboratory self-efficacy perception of the pre-service science teachers before and after the application. Roberts et al. [36] stated in their study that teaching approach which includes activities regarding the professional development of pre-service science teachers with low self-efficacy perception had an important effect on improving the self-efficacy perception level. Eshach [37] stated that research and inquiry based method positively affects the self-efficacy perception of the teachers who participated in introductory workshops. In a similar study, Lee et al. [38] underlined that positive changes occurred in teachers' perception regarding Inquiry based instruction during their professional development process. It was concluded that pre-service science teachers taking science courses during which Inquiry based instruction approach was applied developed a positive perception regarding research and inquiry based laboratory teaching [39].

5. Suggestions

It was concluded in the study that the application of Inquiry based instruction approach had positive effects on the scientific process skills and laboratory usage self-efficacy perception levels of the pre-service science teachers. Some suggestions were made accordingly:

1. Teaching approaches allowing the development of scientific process skills within the laboratory environment should be applied and activities should be prepared to develop these skills.
2. Research and inquiry can be adapted to different lecture contents and it can be ensured for students to reach the information themselves instead of theoretical knowledge.
3. Students can be encouraged to access true knowledge by allowing them to research and question instead of presenting them readily available and acceptable knowledge.
4. Self-efficacy perceptions of the students can be improved by including activities to the learning environment during which students take responsibilities.

REFERENCES

[1] Lloyd, J. K., Braund, M., Crebbin, C., & Roy, P. (2000). Primary teachers' confidence about and understanding of process skills. *Teacher Development, 4* (3), 353-369.

[2] Trowbridge, L. W., & Bybee, R. W. (1996). *Teaching secondary school science: Strategies for developing scientific literacy*. Upper Saddle River, NJ: Merril/Prentice Hall.

[3] Brown, P. L., Abell, S. K., Demir, A., & Scmidt, F. J. (2006). College science teachers' views of classroom inquiry. *Science Education, 90*, 784-802.

[4] Edelson, D.C., Gordin, D.N. & Pea, R. D. (1999). Addressing the challenges of inquiry based learning through technology and curriculum design. *Journal of the Learning Sciences*, *8*(3-4), 391-450.

[5] Suarez, M. L. (2011). *The relationship between inquiry–based science instruction and student achievement.* Unpublished Doctoral Dissertation, The University of Southern Mississiphi, Mississiphi.

[6] Hook, S. J., Huziak-Clark, T. L., Nurnberger-Haag, J., & Ballone-Duran, L. (2009). Developing an understanding of inquiry by teachers and graduate student scientists through a collaborative professional development program. *Electronic Journal of Science Education, 13*(2), 30-61.

[7] National Research Council. (1996). *National Science Education Standards*. Washington, D.C.: National Academy Press.

[8] Leonard, W. H. (1984). An experimental test of an extended discretion laboratory approach for university general biology. *Paper Presented to the Annual Meeting of the National Association for Research in Science Teaching,* New Orleans.

[9] Rissing S.W., & Cogan J.G. (2009). Can an ınquiry approach ımprove college student learning in a teaching laboratory? *CBE Life Sci Educ,* 8, 55–61.

[10] Marx, J.G., Honeycutt, K.A., Clayton, S.R., & Moreno, N.P. (2006). The Elizabeth Towns Incident: An ınquiry-based approach to learning anatomy developed through high school-university collaboration. *The American Biology Teacher, 68*(3), 140-147.

[11] Ulu, C. (2011). *The effect of using inquiry based approach known as the science writing heuristic on concept learning, science process and metacognition skills in science teaching.* PhD. Thesis, Marmara University, İstanbul.

[12] Perry, V. R., & Richardson, C. P. (2001). *The New Mexico tech master of science teaching program: An exemplary model of inquiry-based learning.* Paper presented at the 31st ASEE/IEEE Frontiers in Education Conference, Reno.

[13] Laipply, R. S. (2004). *A case study of self-efficacy and attitudes toward science in an inquiry-based biology laboratory.* PhD Thesis, Akron University.

[14] Chu, S., Chow, K., Tse, S., & Kuhlthau, C. C. (2008). Grade 4 students' development of research skills through ınquiry-based learning projects. *School Libraries Worldwide*, *14*(1), 10-37.

[15] Kramer, A. D., Guillory, J. E., & Hancock, J. T. (2014). Experimental evidence of massive-scale emotional contagion through social networks. *Proceedings of the National Academy of Sciences*, *111*(24), 8788-8790.

[16] Lord, T., & Orkwiszewski, T. (2006). Moving From Didactic to Inquiry-Based Instruction in a Science Laboratory. *American Biology Teacher,* 68(6), 342Y345.

[17] McNicholl, J. (2013). Relational agency and teacher development: a CHAT analysis of a collaborative professional inquiry project with biology teachers. *European Journal of Teacher Education, 36*(2), 218-232.

[18] Hadjichambis, A. C., Georgiou, Y., Paraskeva Hadjichambi, D., Kyza, E. A., & Mappouras, D. (2015). Investigating the effectiveness of an inquiry-based intervention on human reproduction in relation to students' gender, prior knowledge and motivation for learning in biology. *Journal of Biological Education*, 49, 1-15.

[19] Philip, J. M. D., & Taber, K. S. (2015). Separating' inquiry questions' and 'techniques' to help learners move between the how and the why of biology practical work. *Journal of Biological Education*, 1-20. doi:10.1080/00219266.2015.1058840

[20] Ekici, G. (2009). An examination of the biology teachers' laboratory self-efficacy perceptions. *The Journal of Ahi Evran University Education Faculty, 10* (3), 25-35.

[21] Wallace, C. S., & Kang, N. (2004). An investigation of experienced secondary science teachers' beliefs about inquiry: An examination of competing belief sets. *Journal of Research in Science Teaching, 4* (19), 936-960.

[22] Martin, J. D. (2009). *Elementary Science Methods A Constructivist Approach* (5th Ed.). Belmont, CA: Thompson Wardsworth.

[23] Longo, C. M. (2011). Designing inquiry oriented science lab activities. *Middle School Journal, September*, *43* (1) 6-15.

[24] Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design & evaluate research in education* (8th Ed.). New York, NY: McGraw-Hill.

[25] Arslan, O., Bahar, M., & Alev, Ç. (2011). *Genel biyoloji laboratuvar kılavuzu [General biology laboratory guide]*. Ankara: Palme Publications.

[26] Geban, Ö., Aşkar, P., & Özkan, İ. (1992). Effects of computer simulation and problem solving approaches on high school. *Journal of Educational Research. 86* (1), 5-10.

[27] Yıldırım, A., & Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri [Qualitative research methods in social sciences]*. Ankara: Seçkin Publications.

[28] White, E. M. (1993). Assessing higher-order thinking and communication skills in college graduates through writing. *The Journal of General Education*, 105-122.

[29] Sadeh, I., & Zion, M. (2009). The development of dynamic inquiry performances within an open inquiry setting: A comparison to guided inquiry setting. *Journal of Research in Science Teaching, 46* (10), 1137-1160.

[30] Campbell, T., Zhang, D. & Neilson, D. (2011). Model based inquiry in the high school physics classroom: An explanatory study of implementations and outcomes. *Journal Science Education Technology*, 20, 258-269.

[31] Akerson, V., Townsend, J. S., Donnely L. A., Hanson, D.L., Tira, P., & White, O. (2009). Scientific modelling for inquiring teachers network (SMIT'N): The influence on elementary teachers' views of nature of science, inquiry, and modelling. *Journal Science Teacher Education, 20,* 21-40.

[32] Wilke, R., & Straits, W. (2005). Practical advice for teaching inquiry-based science process skills in biology. *The American Biology Teacher, 67* (9).

[33] Windschitl, M., Thompson, J., & Braaten, M. (2008). Beyond the scientific method: Model-based inquiry as a new paradigm of preference for school science investigations. *Science Education, 92* (5), 941-967.

[34] Hatton M. & Scholer, A. (2008). College student's perceptions of scientists. A paper presented at the National Science Teachers Association, Boston, MA.

[35] Roberts, J. K., Henson, R. K., Tharp, B. Z., & Moreno, N. P. (2001). An examination of change in teacher self-efficacy beliefs in science education based on the duration of in-service activities. *Journal of Science Teacher Education, 12* (3), 199-213.

[36] Eshach, H. (2003). Inquiry-events as a tool for changing science teaching efficacy beliefs of kindergarten and elementary school teachers. *Journal of Science Education and Technology, 12* (4), 495-501.

[37] Hubbard, P., & Abell, S. (2005). Setting sail or missing the boat: Comparing the beliefs of preservice elementary teachers with and without an inquiry-based physics course. *Journal of Science Teacher Education, 6*, 5-25.

[38] Lee, C. A., Hart, J. E., Cuevas, P., & Enders, C. (2004). Professional development in inquiry-based science for elementary teachers of diverse student groups. *Journal of Research in Science Teaching, 41* (10), 1021-1043.