AN INTEGRATIVE APPROACH TO THE DEVELOP PRACTISING SKILLS OF PHYSICS PRE-SERVICE TEACHERS REGARDING THE LABORATORY APPLICATIONS

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An Integrative Approach to Develop Practicing Skills of Physics Pre-Service Teachers Regarding Laboratory Applications

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Abstract. The purpose of this research to develop and evaluate an integrative approach for practicing skills on laboratory applications of pre-service teachers in the context of the courses “Secondary Physics Experiment Design” and “School Experience”. Research was implemented based on developer action research with the 20 physics pre-service teachers who were studying 5th-grade in the process of 2015-2016 and 2016-2017 academic years spring semesters at KTÜ Fatih Faculty of Education Department of Mathematics and Science Education. Physics pre-service teachers have been provided with micro-teaching practices for laboratory applications in the course of Secondary Physics Experiment Design (SPED) in the faculty and School Experiences (SE) in the application schools. At the end of the SE process, it was concluded that the activities carried out within the scope of the research before and after the application contributed significantly to the development of the pre-service teachers’ practicing skills in the physics laboratory applications.

Key words: Physics pre-service teachers, Laboratory applications, SPED, SE, Integrated approach.

1. Introduction

Laboratory studies develop the skills of the application by the students’ taking part in scientific activities that consist of applications like students’ searching, asking, proposing solutions, guessing, having comment, analyzing the data, thinking in critical way, getting the scientific methods and explaining the examples [1, 2]. At the student’s success of science education and their having positive attitude and behavior towards science, there have been remarkable effect of laboratory applications supported by many physics educators [2]. It’s pointed out that there have been a great relation of students’ difficulties in learning or their being unsuccessful with not having effective teaching-process except from students’ learning potential [3, 4]. Teachers’ application skills in physics teaching, different laboratory methods, take place among the main factors that affect choosing the method in teaching process [5]. In this context, it’s pointed out that there’s a lack of the expected level in the science pre-service teacher’ executing the effective laboratory applications [6, 7]. Moreover having the failure to develop the physics teachers’ different laboratory methods’ skills at aimed level affects the students’ success degree in physics teaching negatively. This situation is explained with the pre-service teacher’ lack of experience at real-school atmosphere and their undeveloped skills in using method richness at laboratory applications, by executing the classical approaches during pre-service education period [6, 8]. There is a great importance of physics pre-service teachers’ having developed the skills at aimed level in planning and applying the alternative laboratory methods during pre-service teacher education in order to apply the laboratory applications effectively. Thanks to that it’s needed to design learning areas that can develop physics pre-service teachers’ laboratory applications executing skills during pre-service teacher education period to contribute to raise quality of the physic teaching [9]. In this case, in order to get the physics pre-service teachers’ method richness in physic laboratory applications, it becomes compulsory of designing, applying and evaluating approaches to have the expected output from executing applications.
2. Purpose
The purpose of this study is to evaluate the application of developing an integrated approach to improve the execution skills of laboratory applications of physics pre-service teachers within the SPED and SE courses in undergraduate program of Physics Teacher Education.

3. Methodology
In the study, the type of emotional/developmental/collaborative action research was used from the types of action research. The researcher personally participated in all of the applications to collect and analyze the systematic data in order to understand and solve the problems encountered.

3.1. Sample
The research consisted of 20 physics pre-service teachers (6 males+14 females) attending the 5th-grade Physical Experiment Design and School Experience courses in the Physics Teaching Program of the Department of Mathematics and Science Education at KTÜ Fatih Education Faculty during the spring semesters of 2015-2016 and 2016-2017 academic year.

3.2. Development of Data Collection Tools and Analysis of Data
In the first phase of the research; the questionnaire prepared to determine the opinions of the physics pre-service teachers about the effectiveness level of the applied approach was applied to the 20 physics pre-service teachers in the sample before and after SPED course. In the second phase; the same questionnaire was used to determine the applicants' ability to apply the methods related to physics laboratory practices after the SE course. The data in the scope of the research were gathered in accordance with questionnaire and semi-structured interviews applied to the pre-service teachers before and after the applications within the scope of the SPED and SE course. The pre-service teachers in the sample of this context were evaluated themselves in terms of the level of development of their application skills in different laboratory methods. In this process, the approaches, methods and techniques used by the physics pre-service teachers within the scope of the laboratory approach applied in one dimension were ranked while the opinions about the pre-implementation and post-implementation levels of the other dimension were ranked in 5 scale (totally: 5, mostly: 4, partially: 3, seldom: 2, none: 1) were used. The obtained questionnaires were analyzed by taking the mean values and interview data into account.

3.3. Application Process
The following steps were followed during the implementation of the study:
- The instructor who conducts the course is concerned with the physics laboratory methods of the pre-service teachers; the course has been carried out by presenting the theoretical information about the induction, deduction, approach based on research, hypothesis testing, demonstration method, TGA methSE, worksheets, simple course tools and station method, experiment activity plan and application examples.
- In this process, the principles and fundamentals of application of laboratory methods, and their advantages and weaknesses were emphasized.
- The pre-service teachers in the SPED course were given consecutive acquisitions in the Physics Teaching Program (2-3 acquisitions) in groups involving 3 individuals at the class level-unit-subject-achievement dimension.
- Each of the group members applied a 20-25 minute process in the classroom environment by selecting a different laboratory method suitable for the same achievements. The pre-service teachers carried out their implementation according to the detailed activity plans they prepared.
- Each of the group members presented the principles of the laboratory method to be applied as well as the reasons for choosing this method was also introduced during the first 5 minutes of the initial phase of their application in the laboratory environment.
- In this presentation, the pre-service teachers prepared a sheet of word document on a computer medium so as to transfer it to projection device or transferring it to a transparency sheet by overhead projector.
- The laboratory approach, methods and techniques have been tried to increase the qualification level of the application by allowing the other physics pre-service teachers watch the video records of sample applications performed by the pre-service teachers.
- Sample plans are transferred to the computer environment and projected on the screen with the projection device to ensure that the activity plans for the practices of the laboratory methods and techniques are prepared more effectively.

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• After the application of each group, the suitability of the application and the selected method and the level of effectiveness were assessed in the laboratory environment by the group members themselves and all the group members who were observers in the individual group at first, and then instructor assessed all the group members individually.

• On the basis of the evaluations, especially the group achievements with together the laboratory method chosen by each group member were examined in terms of "gains-method suitability". Thus, after each group application, the most effective laboratory method for group gains was investigated based on the discussions made.

• In the activity plans prepared by the pre-service teachers, it is required to specify the principles of the selected laboratory method and the implementation phases in italicized form. In this case, it is foreseen that the stated principles will contribute to the increase of the level of consistency of the activity plans prepared by the physics pre-service teachers and the chosen method.

• As a researcher, the instructor who lectures in the course has informed the physics pre-service teachers during the implementation process to ensure that they reflect the different aspects of their teaching skills in a detailed and consistent manner. At this stage, care has been taken to ensure active participation of students. In this process, the researcher has often played a leading role.

• After realizing the micro-teaching practices in the SPED course, the pre-service teachers tried to integrate and reinforce the acquired skills in the same way during the SE course by reapplying them in the real school environment of the implementation schools. In this process, the physics pre-service teachers who practice the application were evaluated by their peers in terms of their ability to apply physics laboratory methods.

• After the SE course, the same questionnaire was used to determine the pre-service teachers' levels of applying the methods related to the physics laboratory practices. The level of the initial and the final level of the SPED course before application and the level of application of the physics laboratory methods at the end of the SE course were evaluated.

4. Findings

The opinions of the physics pre-service teachers about the effect of the laboratory methods on their application skills were arranged based on the questionnaire applied to the physics pre-service teachers before and after the SPED and SE courses and the semi-structured interview findings conducted.

4.1. Survey Findings

Table 1 show the mean values of opinions about pre- and post-SPED lessons and post-SE course physics pre-service teachers' levels of developing laboratory practice skills.

<table>
<thead>
<tr>
<th>Laboratory Methods</th>
<th>Before SPED</th>
<th>After SPED</th>
<th>After SE Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction</td>
<td>2.15</td>
<td>4.45</td>
<td>4.05</td>
</tr>
<tr>
<td>Deduction</td>
<td>2.20</td>
<td>4.50</td>
<td>4.10</td>
</tr>
<tr>
<td>Demonstration</td>
<td>2.40</td>
<td>4.70</td>
<td>4.00</td>
</tr>
<tr>
<td>POE</td>
<td>2.70</td>
<td>4.80</td>
<td>3.95</td>
</tr>
<tr>
<td>Simple Course Tools</td>
<td>2.35</td>
<td>4.80</td>
<td>4.15</td>
</tr>
<tr>
<td>Station</td>
<td>1.95</td>
<td>4.80</td>
<td>4.10</td>
</tr>
<tr>
<td>Working Paper</td>
<td>3.60</td>
<td>4.80</td>
<td>4.25</td>
</tr>
<tr>
<td>Hypothesis Testing</td>
<td>1.45</td>
<td>2.95</td>
<td>2.10</td>
</tr>
<tr>
<td>Research Based</td>
<td>1.35</td>
<td>2.45</td>
<td>1.70</td>
</tr>
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Graph 1. Practice levels of physics pre-service teachers before and after SPED lesson and after SE lesson.

As seen in Graph 1; before SPED course, physics pre-service teachers consider that they can apply laboratory methods at highest levels: TGA (2.70), demonstration (2.40) and simple course tools (2.35), while they think that they can apply laboratory methods at a minimum level: the research method based approach (1.35) and hypothesis testing (1.45). After SPED course, although the physics pre-service teachers think that they have developed a great degree of application skills in methods of station (1.95-4.80), working paper (3.60-4.80) simple teaching tools (2.35-4.80), deduction (2.15-4.45), induction (2.20-4.45) and demonstration (2.40-4.70), they think that they have developed a lower degree of application skills in methods of TGA (2.70-4.80), hypothesis testing (1.45-2.95), and research-based approach (1.35-2.45). After SE course, pre-service teachers indicates that there is a partial decrease in deductive (4.45-4.05), induction (4.50-4.10), demonstration (4.70-4.00), simple course tools (4.80-4.15), station (4.80-4.10) and working paper (4.80-4.25) while there is a significant decrease in TGA (4.80-3.95), hypothesis testing (2.95-2.10) and research based approach (2.45-1.70). In this case, although the physics pre-service teachers think that they have developed the practical skills of laboratory methods to a great extent before and after SPED course, it is on the scope of SE course that the application skills are partially lower at the end of the real school environment. However, it was determined that the integration of the applications carried out within the scope of SPED and SE course during the application period of the research, and that the physics pre-service teachers contributed greatly to the development of the application skills of laboratory methods (Table 1, Graph1).

4.2. Interview Findings

Here are sample examples of findings from semi-structured interviews aimed at determining the opinions of physics pre-service teachers about their impact on the development of practice skills of physics laboratory methods:

K20: "I have analyzed the fact that the effectiveness of the practice of applying it in this way has not reached the goal of the experiment being carried out so that the effect on the student is not at a sufficient level. But, when we combined the experiment with a lesson, we saw that the lesson increased its effectiveness on the student."

K2: "In the video recordings I watched, I was not able to observe what I would do in noisy classrooms, how I would behave in crowded classrooms because the people in the class were less and did not reflect the truth because we did not address the same level of education."

K7: "After taking SPED course, they noticed that in addition to developing the theoretical knowledge about physics laboratory methods to a great extent, they also had the opportunity to improve their experience and to overcome their deficiencies in applying the methods within the scope of applications. Some of the sample statements regarding the students’ opinions after the practice in the real school environment in the practice schools within the scope of the SE course in terms of influencing the development of the applicants’ practice of physics laboratory methods are:

K1: "These methods have a great impact on our practice in a real educational environment in the school environment. Because we do not get feedback when we practice the experiment design lesson, because they are our
own class and because their knowledge level is higher than a high school level, they already know it but they do not want to answer it. It is also possible for students to be able to see their thoughts on these methods, and on this account, it is possible for us to think about and improve how we should use this method. My friends were doing very well during the application.”

K2: “I compared the laboratory methods I took in experimental design with the big differences in how I applied it within the scope of SE. I developed myself in this sense as I was putting the information into practice in theory.”

K4: “We have gained a lot of skills when we pour these methods into practice in a real education-teaching environment in the school environment and apply what we know in theory. For example, when we do not see the efficiency of the method we use in experiment design, we can get feedback from the students here, and we have a chance to correct the misconceptions instantly during the activity. We are improving our cognitive levels of students; we cannot develop this approach in experimental design.”

K2: “We cannot assess ourselves because we do not have video recordings in the SE, but it is easier for us to criticize our friends as an observer from outside. For example, where they wasted time in practice, or what is more important in practice, or lack of knowledge in their work. We also aimed not to do this in our own applications while considering the mistakes.”

Participants’ ideas about the applicability of what they learn in SPED courses to schools;

K15: “The lessons learned in the SPED course have had a lot of information about how to use the experimental methods in the classroom. Setting the class time can be difficult. We need to adjust the class time by considering the number of people in the class.”

K16: “These techniques, which are resistant to learning in in-service trainings of teachers who have been over a certain period of profession or who do not want to defeat themselves, can indeed be integrated into all classes. In physics, not every technique is easy to apply, but it contains testable subjects that give you the opportunity to do many experiments in the lab. The experimental design I have taken through a semester shows its applicability in the class. Practitioner avoiders are either teachers who do not know the characteristics of the techniques or those who want to do their job easily. Each course cannot be explained with these techniques, but sometimes it can be very effective in straight expression.”

K18: “I think that it is applicable to educate students who are able to teach the subjects, concepts and situations to be taught as much as they can, as well as to develop students’ ability to analyze and synthesize, why, how to answer questions, why to learn much from memorizing information.”

As you can see; The SPED lessons have shown that although the physics pre-service teachers’ responses to their peers are largely attributable to the application of physics laboratory methods, the methods contribute to the development of application skills to a limited extent. Applicants emphasize that the application of physics laboratory methods in real school environment in application schools and monitoring and evaluation of applications of other students in SE classroom have an important positive effect on the development of application skills of physics laboratory methods in overcoming this inadequacy.

5. Discussion

When compared the processes of SPED subject’s before and after, it can be expressed that there’s a great rise of physics pre-service teachers’ awareness towards laboratory methods. It is identified that physics pre-service teachers also developed the skills of service-developing needs by having different ideas, taking into account application and application results with teaching process and laboratory applications, as a result of related experiences and researches. This state shows that physics pre-service teachers get very different opinions and experiences with their own teaching methods according to the subject’s aims. In this process, pre-service teacher think that physics laboratory methods develop application skills by using knowledge and skills that are obtained from their experiences including SPED and SE subjects. In this context, pre-service teachers point out that they can develop new strategies for available situation by dealing with the effectiveness level of practical applications towards laboratory methods, using obtained experiences, taking students own experiences into process and discovery; urging them in asking, suggesting solutions, guessing organizing data, explaining examples; evaluating their knowledge, skill, idea and manner in a consistent way.

At SPED subject, besides the great contribution of the rise of theoretical lack knowledge related with applications’ physics laboratory methods in carrying out their experiments in front of the peers it’s stressed out that there’s a limited contribution in developing application skills of methods on the other hand, pre-service teacher think that they develop preparing experiment activity plan, designing experiment mechanism, planning and applying skills at application schools’ SE subject in real school atmosphere in continuation of faculty’s SPED subject in front of their peers. It stands out that in this process the integration of experiences which are obtained by pre-service teachers’ having chance of practicing different laboratory methods and observing and evaluating their other friends’ applications, makes huge about contribution to the development of physics laboratory methods’ application skills.
6. Conclusions

It can be pointed out that physics pre-service teachers get very different ideas and experiences related with their own teaching applications according to the subject missions by having the choices of resolving the lacks and increasing the experiences in processing applications, in front of the peers at SPED subject, faculty. Moreover, it’s taken over that micro-teaching applications which are applied in front of the peers at faculty’s lab atmosphere at SPED subject, carry the quality as preparation to the applications at real-school environment. On the other hand, it can be expressed that pre-service teachers contribute to their service skill developments at laboratory methods application area by preparing experiment activity plan, designing experiment mechanism, planning and applying skills [10]. In this process it can be concluded that the integration of physics pre-service teachers’ micro-teaching applications that are applied in front of their peers, at SPED subject, physics laboratory methods, with their physics laboratory applications that are carried in real-school atmosphere at SE subject at application schools, make contribution to their having practical ideas and examining teaching applications by observing and applying their laboratory methods.

7. Suggestions

In the process of pre-service teacher education, SPED subject has to be provided as a basis of the physics pre-service teachers’ new laboratory activity designing skills developments dealing with the development of effect level of their physics laboratory methods skills by constant updating in the light of the subject content’s new researches. The needs of cutting up the disconnection physics teachers’ theory and application in the area of different laboratory methods’ application have to be provided by education courses in-service in this area. It must be stressed out that the applications’ integration of SPED and SE subjects has a positive effect on the development of pre-service teachers’ physics laboratory methods application skills. In this context, the contents of the subjects and their applications must be executed by integrating with suitable subjects in order to give place to the lacks-resolving activities about service skill development. In this application process, it mustn’t be forgotten that physics pre-service teachers’ service skill development can be positively influenced at a higher level when integrated with related subjects’ executing applications by stressing out the importance and continuity necessity about providing the pre-service teachers’ service skill development.

References