



## “The Inquiry-Based Learning” From Pre-Service Science Teachers’ Perspective<sup>1</sup>

### Fen Bilgisi Öğretmen Adaylarının Penceresinden “Sorgulamaya Dayalı Öğrenme”

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#### Öz

Fen Bilimleri dersinin içeriğinde soyut birçok kavramın bulunması, öğrencileri ezberlemeye yönlendirebilmektedir. Bu durum öğrenciler için kalıcı bir öğrenme sağlayamamaktadır. Bu sebeple 2017 yılında yeniden düzenlenen Fen Bilimleri Öğretim Programı, sorgulamaya dayalı öğrenme yoluyla fen okuryazarı bireyler yetiştirmeyi hedeflemektedir. Bu sürecin önemli bir bölümünü sürecin uygulayıcısı olan öğretmenler oluşturmaktadır. İyi planlanmış bir eğitim süreci sağlayabilmek için ise öğretmen adaylarının sorgulamaya dayalı öğrenme konusundaki ilk deneyimlerine ilişkin görüşlerini bilmemiz gereklidir. Bu kapsamda bu çalışmanın amacı fen bilgisi öğretmen adaylarının sorgulamaya dayalı öğrenmeye ilişkin görüşlerini incelemektir. Araştırmada durum çalışması deseni kullanılmıştır. Çalışma 2014-2015 güz yarıyılında bir devlet üniversitesinin Fen Bilgisi Öğretmenliği programında 3. sınıfta öğrenim görmekte olan 40 öğretmen adayı ile yürütülmüştür. Öğretmen adaylarıyla, Fen Öğretimi Laboratuvar Uygulamaları dersi kapsamında planlanan konulara yönelik sorgulamaya dayalı deneyler tasarlanmış ve uygulanmıştır. Açık uçlu sorulardan oluşan bir anket kullanılarak veri toplanmıştır. Betimsel analizi yapılan verilerden elde edilen bulgular, öğretmen adaylarının sorgulamaya dayalı öğrenme sürecine ilişkin olumlu görüşlerinin olduğunu ve uygulama boyutunda öğretmenlerin karşılaşabileceği bazı zorlukların bulunduğunu göstermiştir. Bu zorlukları aşabilmek için ise öğretmen adayları uygulama sürecine ilişkin bir takım çözüm önerileri sunmuşlardır.

#### Abstract

The existence of many abstract concepts in Science lessons can lead students to memorize them. This situation does not provide permanent learning for the students. Science education curriculum revised in 2017 aims to prepare science literate individuals via inquiry-based learning. A major part of this process consists of teachers who are the practitioners of the process. To provide a well-planned training process, we need teacher candidates' views about their early experiences of inquiry-based learning. In this context, the aim of this study was to investigate pre-service science teachers' views related to inquiry-based learning. The case study was employed in the research. Practices were conducted with 40 third-grade pre-service science teachers from a state university during 2014-2015 fall semester. Inquiry-based experiments were developed within the Science Teaching Laboratory Applications course and carried out with the participants. A scale of open-ended questions was used to collect data. The findings from the descriptive analysis indicated that teacher candidates had positive attitudes towards inquiry-based learning process and there were some challenges teachers faced during the implementation process. To overcome these difficulties, teacher candidates suggested some solutions for the implementation process.

#### Anahtar Kelimeler

sorgulamaya dayalı öğrenme  
fen eğitimi  
öğretmen adayları

#### Keywords

inquiry-based learning  
science education  
pre-service teachers

1. This study was presented as oral presentation at VII. International Congress of Educational Research.

## 1. Introduction

The age we live in, needs science- literate individuals who are able to interpret the information in addition to understand it. In other words, people are expected to react to information and ensure its development rather than merely understanding it. Moreover, the greater the number of these individuals is, the easier it will be to make progress as a society. The educational policy of our country is organized in the direction of this global race. It aims to educate individuals who know the ways to reach the information. Thus, students may not only successfully complete their personal development, but also become well-educated scientists of the society. Science Education assumes this role in primary education. In addition to its crucial role, science education include some barriers in practice. Because science courses include many abstract concepts, students tend to memorize information. However, memorizing cannot ensure permanent learning which is important for next learning experiences. Researches to provide permanent learning offer new approaches and methods like problem-based learning, inquiry-based learning, and argument-based learning. Using these new methods, they aim to provide more concrete experiences and more effective learning. Therefore, the Science Education Curriculum was revised in 2017. It is based on inquiry-based learning (MEB, 2017). Inquiry-based learning (IBL) is defined as a process in which problems are created and students perform activities to solve such problems (Wood, 2003). With the help of new learning areas in the curriculum, students are firstly expected to assume responsibility to figure out the things happening around them by following scientific processes (such as observation and prediction), and further improve their knowledge by adding new ones. Inquiry-based learning (IBL) gives this responsibility to students (Gençtürk & Türkmen, 2007). The IBL approach aims performing researches, analyzing and solving problems. This approach requires encouraging individuals to acquire information by searching and questioning instead of memorizing concepts and pile of information. Therefore, this approach remarkably helps individuals acquire scientific skills and knowledge they need in their daily lives. This process also helps raising more active and productive individuals, by allowing them to inquire and review all the existing information. By taking individual responsibilities, students will be able to study like scientists and express their ideas more confidently. The practices performed provide a more enjoyable learning process for students. IBL also significantly contributes to development of questioning skills, scientific process skills and self-regulation skills that are aimed to make students achieve. Making research and studying like a scientist give opportunities to use and develop these skills (Wu & Hsieh, 2006).

In the literature, there are various findings noting the positive effects of IBL on science learning process (Tatar, 2006; Duban, 2008; Çalışkan, 2009; Parim, 2009; Oğuz-Ünver & Yürümezoğlu, 2014). For example, the studies on primary school students remark that inquiry-based science lessons have positive effects on students' academic achievements, scientific process skills and attitudes towards science lesson. In addition, these students significantly differ from control groups (Tatar, 2006; Duban, 2008). Furthermore, it has been observed that students are more willing and more active during the IBL process (Oğuz - Ünver & Yürümezoğlu, 2014; Duran, 2015), and students' inquiry skills have improved thanks to inquiry-based activities (Wu & Hsieh, 2006). Studies at high school level remark that inquiry-based courses have positive effects on students' academic achievement and attitudes towards the course (Sakar, 2010). Moreover, they state that students' interest and motivation to learn science also increased significantly (Wu, Wu, Shih & Wu, 2014). It is possible to see similar results in undergraduate level. Karamustafaoğlu and Celep Havuz (2016) compared the effect of traditional and IBL process on preservice teachers' "inquiry-based science teaching" and "IBL skills perception" in their study. In the study, a group of teacher candidates experienced activities by inquiry, while other group experienced by traditional process. Findings revealed that inquiry group had significantly higher scores than the control group. In another study, teacher candidates' conceptual understanding increased by IBL (Kayacan & Selvi, 2017). Furthermore, teacher candidates states that they enjoy inquiry-based activities and the whole IBL process (Şen, Yılmaz & Erdoğan, 2017).

Studies report not only positive feedback about IBL, but also some barriers and challenges. Students show the first part of the inquiry-based courses as the most difficult part. However, they see it as the way to work better in groups (Şen, Yılmaz & Erdoğan, 2017). In addition, teacher candidates who experienced IBL underline some barriers in like lack of time, lack of material, readiness, guidance and content knowledge (Bayram, 2015). Similarly, teachers report that they encountered some problems in implementation of the IBL. They see their lack of experience in terms of practice as the reason. Kazempour (2009) noted that teachers are hesitant to introduce inquiry-based practices to their classes. She reported that the cause of such hesitation is teachers' lack of experience in such practices. On the other hand, some teachers experienced challenges on designing inquiry-based activities despite their ability to carry out inquiry-based learning practices successfully (Marlow & Stevens, 1999). As a solution-focused study, Lundstrom, Jönsson and Nilsson (2014) organized inquiry-based workshops for teachers from high schools, and explained teachers both the IBL approach and related sample practices. Following such practices, they examined if teachers used IBL approach in their classes. They observed that 50% of the participants used the IBL in their classes. Additionally, the participants reported that they felt

themselves more experienced during this training and they needed much more training to achieve IBL properly. The other 50% of participants explains the need for better training programs.

As stated in studies, IBL has many positive effects in terms of many variables of learners on different levels. However, there are some shortcomings and challenges for an ideal IBL process. Even, teachers and teacher candidates, who are the guides for applying IBL in their class, underline their inadequate experience about IBL practices. These findings mean that an effective IBL process needs less shortcomings and a well-prepared practice. Hence, as a long-term study, we planned an IBL course at undergraduate level. To enhance the effectiveness and quality of our course, we needed to form practices according to interests, requirements and profile of the students in our working area. The way to achieve this was to provide students experience the process and make a proper observation of the IBL from their perspective. Therefore, this study was the first step for our main research. The purpose of this first study was to investigate pre-service science teachers' views related to IBL. The results from their positive and negative feedbacks on IBL process would provide important clues to help forming both our IBL practices and other new studies at undergraduate level.

## 2. Method

The study used case study that is a qualitative research design to investigate pre-service teachers' views related to IBL. Activities were carried out with 40 teacher candidates studying in Science Education Department at a state university during fall semester of the academic year 2014-2015. Courses were performed in scope of the Science Teaching Laboratory Applications course.

### Implementation Process

The study was mainly constructed on the frame consists of the steps "providing participants to meet the IBL approach", "presenting sample activities to them" and "providing participants to design and present their own inquiry-based experiments to the class".

Prior to the process of practice, researchers examined the content of the Science Teaching Laboratory Practices course and the plan was prepared for the activities in scope of this course. The plan of the course aimed at ensuring pre-service teachers to use the science laboratory properly and to be able to design experiments in line with the subjects and learning outcomes of the Science course by taking a number of aspects into consideration such as proper use of the science laboratory and safety of the laboratory. The lessons were conducted by the researcher.

Practices were performed within 2 hours per week for a period of 10 weeks. Sample activities were organized and worksheets were prepared for use in such activities in order to ensure teachers to learn about the concept of IBL and the process of learning. During first 3 weeks, the concept of IBL was introduced and the sample activities were applied with participants. Those activities were designed in the frame of guided-inquiry. Traditional structured experiments are the ones that teacher candidates have seen for long time. In addition, open-ended inquiry is a little complex for teacher candidates because of their familiarity with traditional methods. Hence, we chose guided-inquiry that is more suitable for undergraduate level students who are familiar with structured "cookbook" experiments. Throughout the activities, teacher candidates were informed about both implementation methods of the activities and the worksheets used. As of fourth week, inquiry-based activity development process was initiated. During this process, teacher candidates were divided into groups, and these groups chose a course subject with related learning outcomes from the Science Education Curriculum. They made necessary theoretical preparations for the chosen subject and learning outcomes, and started to develop inquiry-based experiments for teaching of the subject. They examined previous sample worksheets before they prepared the worksheets for the experiments they designed. (One of the experiments is given in Appendix-1)

All experiments designed were presented to other pre-service teachers within the time periods given for groups for seven weeks. During their presentations on the determined subjects and learning outcomes, pre-service teachers performed their experiments along with the lecturing on the subject. The lecturing was followed by questions- answers section between pre-service teachers and the presentation groups, which ensured them to exchange information about processes of activity. By this way, pre-service teachers found the opportunity to review their experiences on their practice. During this stage, pre-service teachers were able to observe the inquiry-based process by assuming the role of a teacher for one week and of a student for the other weeks. Thus, they were able to experience possible circumstances which may be encountered during this process both from the student's and the teacher's perspective.

### Data Collection and Analysis

Pre-service teachers' opinions on IBL were collected via a scale consisting of open-ended questions prepared by the

researcher. While selecting the open-ended questions of the scale, firstly the questions were created and submitted to four field experts. The questions were revised in line with the reviews of the experts in terms of both form and content of the tool. Later, a pilot test was conducted with two students other than the participants and the questions were reviewed in line with the answers given. Six open-ended questions in total were available in the final form of the scale. The final form of scale was applied to the participants at the end of the course in last week.

The descriptive analysis was chosen to analyze the data from the open-ended questions. In scope of the descriptive analysis, three researchers examined all of the expressions mentioned in the answers and these answers were recorded as codes and frequencies. Later, the consistency between the results was examined in line with the codes created by the researchers and the number of repetition of those codes. For the consistency, Miles and Huberman (1994)'s percentage of agreement formula:

$$\text{Percentage of Agreement} = [ \text{Consensus} / (\text{Consensus} + \text{Dissidence}) ] \times 100$$

By using the percentage of agreement formula, the reliability of the research was calculated as 93%. Miles and Huberman (1994) stated that reliability ratio of the research may be considered satisfactory on the condition that the similarity of assessment by researchers on qualitative data is 80% or higher. The percentage of agreement achieved manifests that the reliability of the research is at a satisfactory level.

### 3. Findings

Descriptive analysis presented the answers under specific themes and codes. According to these findings, the answers given by pre-service teachers were collected under three main titles: “Features of the learning process”, “Challenges encountered during learning” and “Suggestions”. These three main titles, which were ascertained as the theme, formed the frame of the sub-titles (codes) under which the answers were classified in detail. The related codes were written under each theme and the number of repetition of the codes was estimated. Later, the codes were sorted according to the number of repetitions and a scheme was created for each theme. Figure 1 shows the codes under the theme “Learning Process” that evaluate the characteristics of the process of learning and the number of people who stated these codes.



Figure 1. Codes under the theme “Learning Process”

When Figure 1 is examined, it is seen that pre-service teachers mostly focus on “learning by doing- experience”, “permanence” and “effectiveness” when defining the features of the learning process. Although the participants took

part in the process as both teachers and students, their expressions manifest that they rather focus on the learning aspect. Considering this situation, we may argue that the process has a bigger effect on the learner. Some example views of participants are as follows:

*“...I tried to be active and a part of the lesson till the end of the lesson. I tried to discover new ones on my own. My results were more meaningful and permanent for me when I learned by doing-living...”*

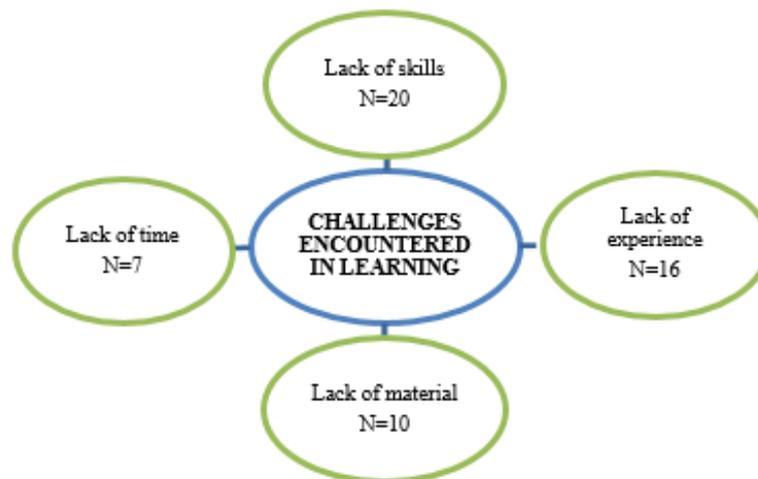
*“...To stay alone with practices was a very different and effective experience for me. I will never forget my simple mistakes that I changed with true ones in my mind by these experiences...”*

In addition, features such as “use of scientific process skills (SPS)”, “creativity”, “entertaining” are essential for achievement of the purpose of Science lesson. Pre-service teachers note that they observed those features in the inquiry-based learning process. That may be an important indicator of the conformity of inquiry-based learning with the Science course. On the other hand, “promoting research” and “concreting information”, to which a remarkable amount of reference is made, is an important objective of both the inquiry-based learning and Science course. Although the quality of “eliminating prejudices” is indicated by very few of the pre-service teachers, this quality may become one of the important contributions of inquiry-based learning in the long term. Some example views of participants are as follows:

*“...I saw that science activities are not so hard to do. I felt like a child who learns everything first time. Everything I did to learn was my own creativeness. Experiencing such activities changed my prejudices related to science from high school...”*

*“...The activities made me search new information and examine my old experiences. It was a bit hard but I learned to use my old information to find new ones. I learned to design an experiment, to observe my friends, to organize my findings and to use them when required...”*

Figure 2 contains the codes appearing under the theme “Challenges encountered in learning”, and the number of repetition of codes.



**Figure 2. Codes under the theme “Challenges Encountered in Learning”**

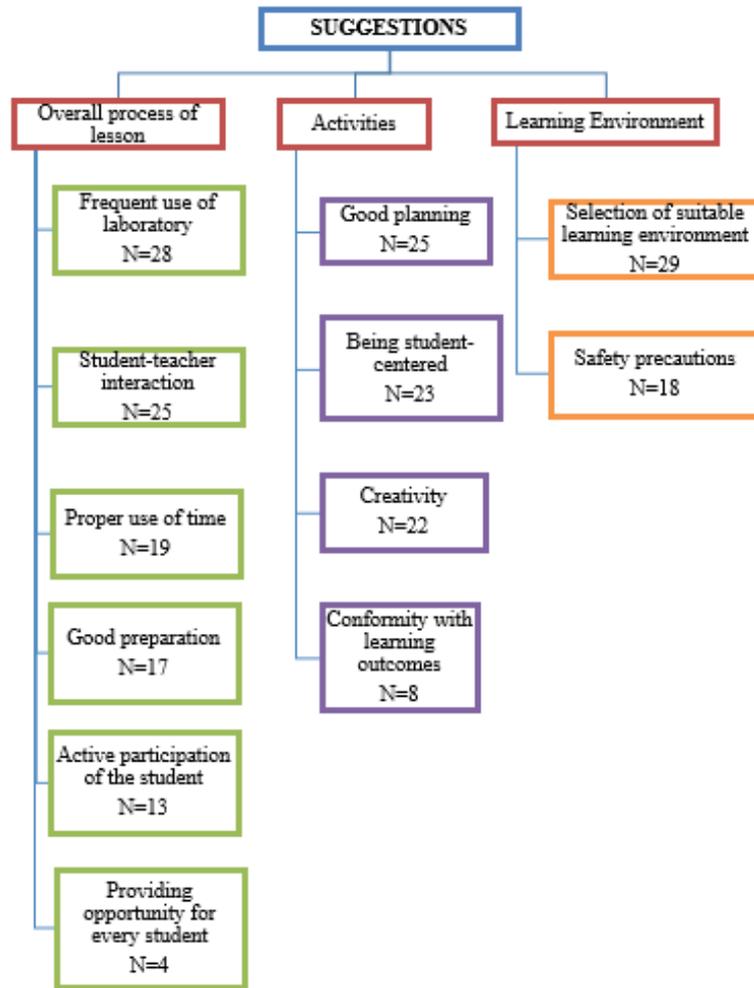
When figure 2 is examined, it is seen that pre-service teachers referred to the challenges encountered in learning process only under four codes. Out of these codes, “lack of skills” and “lack of experience” remain in the forefront. The participants justified the failures they encountered while doing experiments in learning and teaching process mainly by their lack of experience in practices and the consequent lack of skills. On the other hand, they also referred to challenges such as the lack of materials and lack of time during the practices. Pre-service teachers noted that they experienced a number of problems especially during the design and application of experiments, as they also assumed responsibility for supplying materials and doing experiments within the specified time. Some example views of participants are as follows:

*“...Our group had some problems in designing the activity. Because we had no idea about what we would use as an original material. We needed to have a look to similar activities for suggestions about material. I think that was not a big problem for many teachers, but we felt less experienced about practices. We need to be more active in especially designing the experiments so that we will have some skills to use materials more effective...”*

“...While we designing an activity for others, I felt more comfortable. Because we had different ideas and activities to present. We would just try to make students more active during course. However, during the course, we noticed that many of our friends could not do the activity easily. They needed our guidance for each new step. We noticed that they were that comfortable with their ability for an activity...”

“...We need more time for such activities. Because we discussed for minutes before starting the activity. These activities require thinking for longer about it especially for people who have experienced less practice. Presenting some simple beginning activities, which make students practicing, may shorten the time spent...”

Figure 3 shows the categories and codes appearing under the theme “Suggestions” in line with the answers of pre-service teachers, and the number of repetition of the codes.



**Figure 3. Codes under the theme “Suggestions”**

When Figure 3 is examined, it is observed that suggestions of pre-service teachers are grouped under three categories, which consist of the overall process of lesson, activities and the learning environment. Participants focus on practices under the category “overall process of lesson”. The codes “frequent use of laboratory”, “student-teacher interaction”, “proper use of time” stand as the essential items for smooth continuation of experimental practices. This reveals that pre-service teachers primarily focus on implementation of experiments. On the other hand, the items “active participation of the student” and “providing opportunity for every student” have appeared as significant elements of the process of learning. It is possible to see by means of the codes how pre-service teachers learn better in the process of inquiry-based learning. When the category “activities” is observed, it is seen that the pre-service teachers focus on “good planning”, “being student-centered”, “creativity”, and “conformity with learning outcomes”. These titles emphasize the points, which the pre-service teachers focus on in order to be able to carry out the process of designing and implementing experiments in a consistent manner. It can also be argued that pre-service teachers justify setbacks they encountered by the achievement status of those items. When the category “learning environment” is examined, the items “selection of the suitable learning environment” and “safety precautions” are seen to be notable. These codes are associated with

the implementation stage of the experiments and are prerequisites of an accurate and safe experiment for pre-service teachers. Data reveal that the pre-service teachers have considered these aspects against potential problems that may appear during applications in the design process of the experiment. Some example views of participants are as follows:

*“...Inquiry activities make lessons easier if the teacher knows when his/her guidance is needed. Because guidance and the students-teacher interaction effects the speed of students’ study. Therefore, the lessons should be well-planned and teacher should know when students may need guidance...”*

*“...To solve the problems like we encountered, laboratory usage and hands on activities should be the biggest part of these lessons. More practice means more learning and more active students...”*

*“...The most important point is learning environment. I always choose the most interesting and the most enjoyable options as a student. Because I want to use as many as options to try new steps in an activity. Therefore, as a teacher, we should provide an enjoyable class to increase students’ creativity...”*

#### 4. Results and Discussion

When the findings are examined, it is observed that almost all opinions of the pre-service teachers on the process are positive. The findings related to the learning process has shown that IBL provides a more efficient and permanent learning, encouraging participants to learn by doing and to follow an inquisitive process. These findings presented by pre-service teachers are coherent with studies which suggest that the IBL guides learners towards an inquisitive process (Wu & Hsieh, 2006) and that the learning process is more active (Oğuz - Ünver & Yürümezoğlu, 2014; Duran, 2015). Moreover, there is an emphasis on the use of scientific process skills and critical thinking skills, entertaining quality of the learning process and concretization of information. These findings also support the studies that emphasize positive effects of the IBL on scientific process skills (Tatar, 2006; Wu & Hsieh, 2006; Duban, 2008; Karamustafaoğlu & Celep Havuz, 2016).

When the challenges encountered in the learning process are examined, the lack of experience and skills in the IBL process and experimental practices is notably seen. This manifests that pre-service teachers primarily need development of their experience and skills in order to become able to perform accurate experimental practices. The results support the studies, which reveal that the lack of experience and skills in terms of practice is the cause of challenges encountered by teachers in the IBL process (Marlow & Stevens, 1999; Kazempour, 2009; Çelik, 2012, Lundstrom, Jönsson & Nilsson, 2014;).

The findings under the theme “Suggestions” show that codes such as “teacher- student interaction”, “adequate preparation for the course”, “design of well prepared and creative activities” have appeared. This situation clearly points out to the responsibilities that learning process, especially the IBL process, brings to teachers. In addition, it shows which points pre-service teachers focus on during designing the activities. The pre-service teachers suggested selection of correct learning environment for IBL and the use of laboratory as the learning environment for science courses. Furthermore, they suggested that safety precautions should be taken for such learning environments in line with the experience gained from practices.

Pre-service teachers took part in the practices as both teachers and students, which enabled them to view the learning process from two different perspectives. As students, they observed how and in which learning environments the learning is achieved and in which conditions the students could be more active and more permanent. They found the opportunity to observe the effects of practices, which address the characteristics of the student, the interaction between the teacher and the student, and a course schedule oriented towards the course and the student. They have concluded that the IBL is an effective and permanent way of learning if the required conditions are provided. From the perspective of a teacher, they experienced the responsibilities imposed by the process of IBL on the part of teachers and the contributions to the educational process by appropriate practices. They reported their experience with their positive statements on the IBL.

The experiences and opinions of teacher candidates, who will be the implementers of the process, are very important to ensure effective implementation of IBL, which is regarded as an important way for achievement of Science Education. Results of studies show that participants put forth some important elements regarding IBL after such practices as both a student and a teacher.

Under the light of the results obtained from the study, the following suggestions for future studies are as follows:

- Especially such practices that proceed gradually on a long-term basis may provide teachers with the opportunity to gain experience that is more permanent. Moreover, practices in next steps may be more effective.

- With such kind of studies in undergraduate practical courses, the pre-service teachers may fully comprehend the IBL and acquire experience to put their knowledge into practice.
- Pre-service teachers may be ensured to adapt to the IBL process more easily than expected if especially the initial activities to be carried out with pre-service teachers are started with confirmatory and guided ones.
- During implementation of the inquiry-based activities at primary and secondary schools, guided inquiry activities may be performed more intensively to build creativity of students.

## 5. References

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**Appendix-1**

**Title of experiment:** Moving balloons

**Course level:** 8th grade

**Subject:** Electrostatic charge and Electrification

**Learning Outcomes:**

- I. Students will become capable of classifying electrostatic charge and will discover the effect of similar and different charges on each other through experiment.
- II. Students will perform experiments on types of electrification and observe their results.

**Application of Experiment:**

- Students will be given two balloons inflated at equal size, small pieces of paper and a piece of wool.
- Then, students are shown how a balloon is electrified by a piece of wool and then attract small pieces of paper. Students will be given some time to apply the same experiment.
- Students will be asked to fill out the related field of the worksheets by writing down their opinions on what kind of an interaction occurred between the piece of wool, the balloon and the small pieces of paper.
- After the students write down their opinions, they will be given some time to briefly discuss their opinions with their group partners.
- Following the discussion, students will be given a new experiment to test their opinions and question new ideas. For the mentioned experiment, students will be asked to use a piece of wool and one of the balloons to move the other balloon without contacting it.
- Students will firstly test how balloons react when they are in static condition. Then they will test the potential repulsive or tractive force applied on the balloon by the other balloon which is rubbed by wool. Then they will examine what type of behavior balloons will display when both of the balloons are rubbed by wool. Using the most effective method they will choose, students will enable movement of the second balloon which will be pushed or pulled without contact.
- Following the mentioned stages of experiment, students will indicate that the balloons sometimes pulled each other while at other times one of the balloons pushed the other. At this stage, students will be asked questions to make a better review of the difference. Students will be asked questions such as “What happened when you rubbed the woolen cloth on only one of the balloons?”, “Did you observe any change when you rubbed the woolen cloth on both of the balloons?”, and they will be ensured to state their opinion on the electrification process of balloons (The most important part of the experiment is the process in which students will create questions and seek answers to those questions. Therefore, this stage of the experiment in which the actual questioning will take place will not involve any direct explanations or solutions offered to students.)
- The last stage will involve explanation of solutions by students and a classroom discussion on the subject. By means of questions, students will be ensured to come to the conclusion that the balloons push one another when they are charged with the identical electrostatic charge and they pull each other in otherwise condition. (Students will be expected to make experiments in line with their own ideas as well as the ideas of their classmates and submit the results of experiments to their classmates. Once the results have been introduced, students will be encouraged to think over the accuracy of results achieved through questions asked by the teacher).