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Abstract

This study is a qualitative case study conducted to examine the deficiencies and needs for the implementation of the investigative inquiry program in physics classes. The study was carried out at Science High School (SHS), Anatolian High School (AHS), and Technical Vocational High School within the scope of purposeful sampling determined according to school type. In the study, observations were made in physics classes. Interviews were conducted with the teachers of the observed classes. The obtained data were subjected to descriptive analysis. Observation and interview data were interpreted together. It was observed that the teachers had classroom discussions over the daily life examples and models in the lesson. It can be said that teachers try to create an inquiry-based teaching environment in this way. It can be said that teachers are willing to teach based on inquiry, but they see some situations as obstacles in practice. Some suggestions are presented in the context of the research results. It is thought that the results of this study and the suggestions made will help teachers and administrators plan and set up activities for in-service training.

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Research Article

Deficiencies and Needs for the Application of Inquiry-Based Learning in Physics Classes [*]

Fatma Nur BÜYÜKBAYRAKTAR [1]

Abstract

This study is a qualitative case study conducted to examine the deficiencies and needs for the implementation of the investigative inquiry program in physics classes. The study was carried out at Science High School (SHS), Anatolian High School (AHS), and Technical Vocational High School within the scope of purposeful sampling determined according to school type. In the study, observations were made in physics classes. Interviews were conducted with the teachers of the observed classes. The obtained data were subjected to descriptive analysis. Observation and interview data were interpreted together. It was observed that the teachers had classroom discussions over the daily life examples and models in the lesson. It can be said that teachers try to create an inquiry-based teaching environment in this way. It can be said that teachers are willing to teach based on inquiry, but they see some situations as obstacles in practice. Some suggestions are presented in the context of the research results. It is thought that the results of this study and the suggestions made will help teachers and administrators plan and set up activities for in-service training.

Keywords: Inquiry-based learning, physics classes, needs for application, deficiencies for application

1. INTRODUCTION

Inquiry in science education has been discussed for years. There are different opinions about the definition of questioning and how it looks like in the classroom (Anderson, 2002). Ernst, Hodge, and Yoshinobu (2017) "What is inquiry-based learning today?" they asked. Researchers have defined inquiry-based learning as a form of active learning in which students are given a carefully scaffolded sequence of tasks and are asked to solve and make sense of them, working individually or in groups. A new inquiry-based learning framework has come out of a study that looked at the most important parts of inquiry cycles in terms of how people learn. In this framework, five general inquiry phases are defined as: orientation, conceptualization, investigation, conclusion, and discussion (Pedaste et al., 2015).

Capps and Crawford (2013) stated factors related to the nature of a teacher's inquiry and science, on which the nature of actual classroom practice depends. These are factors: knowledge, views on the nature of scientific inquiry and science, pedagogical knowledge, and students' knowledge. Khalaf and Mohammed Zin (2018) conducted a systematic and critical analysis of two dominant learning models, traditional and inquiry-based learning. As a result of the study, they summarized the pedagogical criteria in the table "Pedagogical criteria of key learning models".

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Table 1. Pedagogical criteria of key learning models*

No	Description	Traditional Learning	Inquiry Learning
1	Theoretical Perspective	Cognitive behaviourism	Cognitive constructivism
2	Teacher Role	Dominant role	Guidance & facilitator
3	Knowledge	Level Limited knowledge	Developed knowledge
4	Skills	Limited skills	Develop skills
5	Confidence	Level Low confidence	High confidence
6	Motivation	High motivation	Low motivation
7	Performance	Low performance	High Performance
8	Learner's Outcomes	Low outcomes	Low outcomes

**Source: (Khalaf & Mohammed Zin, 2018)*

Looking at Table 1, pedagogical criteria are defined as the following: theoretical perspective, teacher role, knowledge, skills, confidence, motivation, performance, and learner outcomes. Literature reveals that an inquiry cycle is usually presented as an ordered sequence of stages. However, researchers stated that inquiry-based learning is not a uniformly linear process. Connections between stages can vary depending on the context (Pedaste et al., 2015). It can be said that the situation in terms of education is complex. Inquiry-based instruction forms the scaffold for the formative assessment of inquiry skills. It also provides the opportunity to assess students' skill development in real time (Chen, Pan, Hong, Weng, & Lin, 2020). It is possible to see evaluation as taking in three forms in the inquiry learning context: the evaluation of thought/conclusion on the basis of data; the evaluation of data validity and the degree of student understanding of the concepts and so on being learned and utilised in the conduct of the inquiry (Kidman & Casinader, 2017). Discussions in an inquiry-based learning setting provide the instructor with information about the student's level of comprehension and facilitate class consensus on issues. In such an environment, both the cognitive and social development of pupils are fostered. It is asserted that the culture of inquiry fostered by the study done in high school physics classes affords pupils the ability to both collaborate and engage in scientific research procedures (Kock, Taconis, Bolhuis, & Gravemeijer, 2015). Aybek, Yalçın, and Öztürk (2019) discovered a strong correlation between critical thinking attitudes and physics success scores. Another study on this topic demonstrates that scientific inquiry supports students' learning interests and engagement. It is stated that the majority of students participating in scientific inquiry activities experience interest and enjoyment (Chen et al., 2020). Meaning-making activities that entail knowledge generation in social interaction facilitate the conceptual development of the individual (Kock et al., 2015). In science education reforms, the framework of inquiry learning that supports the nature of science is a topic of interest. Organizations such as the European Commission (EC), the National Research Council (NRC), the National Science Foundation (NSF) carry out important studies to improve science education. The Organization for Economic Co-Operation Development (OECD) has conducted a large-scale assessment of science, reading, mathematics, financial literacy and collaborative problem solving. This assessment emphasized the importance of inquiry-based teaching and curriculum development (OECD, 2017). Many countries are reforming K–12 curricula to develop systems that support science instruction. The purpose of these reforms is to create an environment that will enable students to understand scientific concepts and procedures. For this, teachers are encouraged to use scientific research in their instruction environments (Minner, Levy & Century, 2010).

Türkiye is one of the nations that has revised its curriculum in order to create an inquiry-based learning environment that will facilitate scientific research. In 2013 and 2018, modifications were made to the physics curriculum in Turkish. According to an assessment of these programs' curricula, scientific process abilities are at the forefront of both (Bezen, Aykutlu, & Bayrak, 2020). Both programs aim to raise awareness of the nature of science and comprehension of the nature of scientific inquiry. Inquiry is geared towards integrating the nature of the scientific enterprise, its practices, and the knowledge production in which science students take part. In this process, students take an active role in the knowledge production of scientific inquiry and logical discourse, similar to scientists in science studies (Aslan-Efe & Özmen, 2018; Dias, Eick, & Brantley-Dias, 2011; Kahyaoğlu & Saraçoğlu, 2018). In this context, it makes sense to include phrases like "producing scientific knowledge using scientific process skills", "solving problems", "justifying assertions with evidence and proof", "evaluating", "interpreting" and "sharing scientific knowledge" in these curricula. The Science Learning Committee's 2007 report laid out the framework for classroom practice and student outcomes on inquiry. In this context, science proficiency as defined, "knows, uses and interprets scientific explanations of the natural world", "generating and evaluating scientific evidence and explanations", "to understand the nature and development of scientific knowledge", "participate productively in scientific practice and discourse" (NRC, 2007). According to these definitions, it can be asserted that the 2013 and 2018 physics curriculum in Turkey were designed to provide students with scientific proficiency.

In an inquiry-based learning environment, however, it is not sufficient to build a curriculum that allows students to comprehend the nature of scientific knowledge. Curriculums that have been created must be implemented in schools. Inquiry practice arises from the interaction between the teacher's teaching experiences and their beliefs about inquiry and classroom practices. Inquiry-based personal practical knowledge developed by teachers affects their teaching skills (Dias et al., 2011). It has always been believed that it is crucial for teachers to present their pupils with engaging learning opportunities and positive motivation in physics class (Bayrak, Bezen, & Aykutlu, 2015). It is thought that teachers should engage students in the educational process by directing them toward investigation and inquiry (Ayvacı & Bebek, 2018). Unfortunately, inquiry-based instruction has not been widely implemented in science classrooms (Capps & Crawford, 2013). According to research in Türkiye, the majority of teachers do not go beyond teacher-centered methods in which the teacher teaches and the student listens (Bayrak et al., 2015; Ergin & Sarı, 2013). There is a requirement for professional development opportunities for teachers in inquiry-based teaching and complementary teaching materials in this field (Chen et al., 2020). There is a need for information about transferring inquiry-based learning to the classroom environment. It is necessary to support teachers in understanding and applying reform-based teaching approaches. It is important to consider what needs to be done in this regard.

Examining the literature, it is evident that there is few research on the difficulties encountered in teaching and learning physics, their causes, and proposed solutions (Ayvacı & Bebek, 2018). The relationship between the physics teachers' teaching philosophies and their teaching practices was investigated in a thesis study. Çardak (2019) concluded that some teachers had a teacher-centered framework and others had a student-centered one. Based on some studies, the problems encountered in the implementation of the program, according to physics teachers, are the weakness of the students' processing abilities, the lack of time to teach the subjects (Bayrak et al., 2015), the lack of classrooms suitable for contemporary teaching methods, and the students' lack of curiosity and unwillingness to learn (Ersoy, Karamustafaoğlu, & Özdoğan, 2018). İnaç and Tuksal (2019) incorporated students' perspectives on physics courses into their research. The findings of this study indicate that students view physics instruction with prejudice. According to the students, the physics course was tough to comprehend. In the study, it was stated that the students' interest in the lesson decreased due to the complexity of the subjects, the laboratories were not used enough and very few experiments were conducted. There are few studies in the academic literature that describe the classroom setting for the implementation of inquiry-based teaching in physics classes. In physics classes, it is essential to highlight the efforts of teachers to create an exploratory and inquiry-based learning environment. Nonetheless, it is vital to identify the circumstances that impede students' ability to comprehend and challenge the nature of science. In this light, the study has addressed the issue "What are the deficiencies and requirements for the implementation of inquiry-based learning in physics classes?"

2. METHOD

2.1. Research Design

The aim of this study is to identify the deficiencies and needs for the application of inquiry-based learning in physics classes. A case study is a qualitative research approach in which the researcher inquiries about the situation through observations, interviews, audio-visuals, documents, and reports and allows the situation to be defined in an intense and holistic way (Creswell, 2007). In the study, observations were made in physics classes within the scope of the case study, and teachers' opinions were taken. In this way, results were obtained for the physics teachers to implement the inquiry-based curriculum in the most effective way.

2.2. Participants

Purposeful sampling enables in-depth research by choosing information-rich circumstances that are relevant to the study's goal. Maximum variation sampling is a kind of purposeful sampling that enables the investigation of research issues in a broader context under various circumstances (McMillan & Schumacher, 2006). According to Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, and Demirel (2012) this sampling technique may provide significant hints regarding the universe's values due to the presence of diverse circumstances in the research. In this study, the type of school chosen for purposeful sampling was used to conduct maximum variation sampling. Observations of physics lessons were conducted in three distinct school types: Science High School (SHS), Anatolian High School (AHS), Technical Vocational High School (TVHS). SHS, AHS, and TVHS are high schools affiliated with the Ministry of National Education in Türkiye.

In all schools, observations were conducted during the eleventh-grade lessons on momentum and the twelfth-grade lessons on wave mechanics. The observations focused on the fact that the three physics teachers chosen on a voluntary basis represented a range of circumstances in terms of gender, tenure, and the institution or program where they got their teacher education. Two of the teachers in the classes where the observations were taken are male, while one is female. Two of the teachers are education graduates. The other teacher is a graduate of the Faculty of Arts and Sciences who completed a certificate program in teacher education. Teachers are appointed for thirteen, sixteen, or twenty-two years. Teachers attend eleven, thirteen, and sixteen in-service training sessions. In the selection of the observation sample grade level, the lesson by these teachers were questioned. It was determined that all three teachers attended the classes in the 11^{th} and 12^{th} grades. The 11^{th} and 12^{th} grades was chosen for the physics lesson observation sample. After the observations, interviews were conducted with three teachers.

2.3. Data Collection and Analysis

The case study's data were gathered through interviews and observations. At SHS, AHS, and TVHS, observations of physics lessons were made. Observations were made by the researcher as a participant observer. The procedure of observation began with obtaining permissions from the Directorate of National Education. The principals and physics teachers at the schools were subsequently interviewed. Observations were conducted in the classrooms of three physics teachers who were chosen voluntarily to reflect a variety of scenarios, including gender, duration of service, and the institution or program where they acquired their teaching education. Observations were made in the physics lessons given by each teacher in the eleventh and twelfth grades. Twenty to twenty-five students are present in each classroom being observed. Together with the instructor of the observed class, the observer reviewed the notes taken during the observations. Regarding the observation notes, verification was received.

The course observations were conducted using the observation form created by the researchers during the research procedure. The form consists of eighteen elements that were developed in accordance with the physics curriculum goals and objectives. Eighteen items are based on fundamental situations, such as "attracting attention at the course's entry, informing students of the course's objectives and accomplishments, and teaching physics courses using the approaches-methods indicated in the program." The participant observer who made the observations jotted down specific details about these fundamental conditions. Specifically, the researcher took notes for each situation within the context of inquiry-based instruction. Following an assessment by two Professor Doctor lecturers who are physics education specialists, it was somewhat modified and given its final form.

Interviews were conducted with three physics teachers teaching in the classroom where the observations were made. The semi-structured interview form used in the interviews has seven open-ended questions that allow for in-depth examination of the teachers' responses. The interview form was reviewed and completed with the assistance of professional lecturers in the area of education.

Interviews were done voluntarily and with participant involvement. Teachers were briefed about the research prior to the interviews. The teachers were asked for permission to videotape the interview. However, many teachers expressed discomfort with this subject. Others said that "it would be better if you did not register." As a result, the researcher documented several interviews only in writing. Throughout the interview process, time was set out for written documentation. Wherever it was considered essential, the phrases were presented or repeated to the teacher, and the teacher's permission was sought. The interviews lasted between 20 and 30 minutes.

A description is used to describe a case's history or present status. The description provides the context for the analysis that leads to interpretation (McMillan & Schumacher, 2006). In this case, the data from classroom observations and the data from teacher interviews were combined and submitted to descriptive analysis. The results were defined and evaluated within the analytical framework.

3. FINDINGS

3.1. Data of Lesson Observations

The data from the lesson observations made in the eleventh and twelfth grades are presented in this section.

3.1.1. Data of eleventh grade lesson observations

Eleventh-grade observations were made in classrooms where momentum was taught. Lesson observations were made in the eleventh grade utilizing the observation form. Table 2 summarizes the data gathered during the observations.

Table 2. Observation data of eleventh grades

Behaviors	**Schools***	**O***	**PO***	**NO***
Attracting attention at the entrance to the lesson, motivating the students to the lesson	SHS	X		
	AHS		X	
	TVHS	X		
Making lesson plans, informing students about the aims and achievements of the lesson	SHS	X		
	AHS	X		
	TVHS	X		
Conducting the teaching of physics subjects with the approaches-methods specified in the program	SHS		X	
	AHS		X	
	TVHS		X	
	SHS		X	

Applying the teaching activities in current physics textbooks	AHS		X	
	TVHS		X	
Explaining abstract concepts using concrete materials	SHS	X		
	AHS		X	
	TVHS	X		
Utilizing instructional technology in topic presentation	SHS			X
	AHS	X		
	TVHS			X
Giving examples from daily life on the subject	SHS	X		
	AHS	X		
	TVHS	X		
Experimenting in the lab or conducting a demonstration experiment in the classroom	SHS			X
	AHS			X
	TVHS			X
Leveraging simulations, models and games	SHS	X		
	AHS		X	
	TVHS	X		
Organizing learning activities suitable for students' individual differences	SHS		X	
	AHS			X
	TVHS		X	
Organizing group learning activities	SHS			X
	AHS			X
	TVHS			X
Creating an environment in which students construct their own learning	SHS		X	
	AHS			X
	TVHS	X		
Creating an environment where students support each other's learning	SHS		X	
	AHS			X
	TVHS		X	
Guidance in using science process skills	SHS		X	
	AHS			X
	TVHS		X	
Enabling students to pose and solve problems using physics concepts	SHS		X	
	AHS		X	
	TVHS		X	
Carrying out activities to eliminate the misconceptions about the subject and prevent the occurrence of misconceptions.	SHS			X
	AHS			X
	TVHS			X
Organizing activities that relate to other subjects of the physics course and sub-disciplines	SHS	X		
	AHS		X	
	TVHS	X		
Measuring and evaluating in accordance with physics subjects and concepts	SHS		X	
	AHS	X		
	TVHS	X		

* SHS: Science High School; AHS: Anatolian High School; TVHS: Technical Vocational High School; O: observed; PO: Partially Observed; NO: Non-observed

The lecture approach, class discussion, case study methodology, and modeling were all utilized to teach momentum in the eleventh grade at SHS. Students are situated according to the traditional seating arrangement in the classroom. The classical seating arrangement is described as a row of parallel seats immediately across from the board. The classroom is equipped with a smart board. The majority of students who attended the session expressed an interest in the subject. It was noted that many students were willing to engage in class discussions and provide observations on the topic. It was noticed that the majority of students worked diligently to solve the teacher's example issue.

In the eleventh grade at AHS, the direct expression technique and modeling were utilized to teach momentum. Students are situated according to the traditional seating arrangement in the classroom. The classroom is equipped with a smart board. It was noted that many of the students who attended the course shown an interest in the subject matter. Certain students have been seen scribbling on the papers in front of them or conversing among themselves while the lesson is being given. It was noticed that just a few students were willing to respond to the teacher's queries and engage in the class. Despite the teacher's cautions, it was noticed that the majority of students chose to talk with their friends rather than solve problems within the allowed time to complete the teacher's exam.

TVHS class discussion, case study method, and modeling were utilized to educate eleventh-grade students about momentum. Students are situated according to the traditional seating arrangement in the classroom. The classroom is equipped with a smart board. At the start of this session, it was noted that the majority of students were uninterested in the subject. It was noted that many students lacked a notepad and pen at their desks. The students' interest in the lecture progressively grew as the teacher inquired about the subject's illustration. Many students began to attend the class when the teacher requested students to provide examples regarding the topic. With the establishment of a chat atmosphere in the classroom, all students started to pay attention to their teacher and classmates. However, it is worth noting that the majority of students offered comments unrelated to the topic. While solving the problems, it was noticed that the students showed a lack of enthusiasm in participating in the class discussion. When the teacher requested them to answer subject-related instances, it was noted that relatively few students were eager to do so. However, relatively few students took notes throughout the course.

3.1.2. Data of twelfth grade lesson observations

The topic of the course, according on observations made in the twelfth grades, is wave mechanics. Since the twelfth grades are preparing for the Higher Education Institutions Exam (YKS), there was no instructional activity in the courses at AHS and SHS other than test solution. As a result, the observation form developed to identify teacher and student actions during instructional activities could not be utilized in the twelfth grades of AHS and SHS. The researcher collected notes while observing these courses.

According to an observation conducted in the twelfth grade of SHS, the teacher said that before entering the classroom, he distributed three wave mechanics exams to the students, which they would complete throughout the lecture. Students were given photocopied exam sheets. Each exam paper has fifteen questions. The teacher allotted students ten to fifteen minutes to complete each exam, as witnessed. Throughout this time period, the teacher went around the classroom, answering questions from students. The teacher resolved some of the questions, while others were resolved by a student selected from among the willing students. While students were completing the problems, the teacher highlighted key points and provided suggestions. All students passed the exams given throughout the session. Additionally, it was noticed that all students attentively followed the teacher's on-board answers to the problems.

At AHS, the teacher handed exam papers to all students that he had photocopied at the start of the session. The teacher allotted the students about fifteen minutes to complete the fifteen-question exam. When the time allotted for the test solution elapsed, the teacher began answering the questions on the board, beginning with the first. The teacher responded to each question and then inquired as to how many students properly answered the question. Then, on the board, she drew the answer to the issue. In several instances, the teacher addressed the question, "Does anybody wish to solve this?" to the students. The teacher assisted students who approached the board in resolving the questions. During this session, it was noted that many students completed the exam. The teacher cautioned students who failed to complete the exam. Despite this, the students did not seem to pay any heed to the warning. However, it was found that students were reluctant to approach the chalkboard to answer problems.

A wave mechanics teaching activity was conducted in the twelfth grade of TVHS. The form was utilized in this class's observation. Table 2 summarizes the data gathered during the observation.

Table 3. Observation data of TVHS twelfth grade

Behaviors	Observed	Partially Observed	Non-observed
Attracting attention at the entrance to the lesson, motivating the students to the lesson	X		
Making lesson plans, informing students about the aims and achievements of the lesson		X	
Conducting the teaching of physics subjects with the approaches-methods specified in the program		X	
Applying the teaching activities in current physics textbooks		X	
Explaining abstract concepts using concrete materials		X	
Utilizing instructional technology in topic presentation			X
Giving examples from daily life on the subject	X		
Experimenting in the lab or conducting a demonstration experiment in the classroom			X
Leveraging simulations, models and games		X	
Organizing learning activities suitable for students' individual differences		X	
Organizing group learning activities			X
Creating an environment in which students construct their own learning		X	
Creating an environment where students support each other's learning		X	
Guidance in using science process skills		X	
Enabling students to pose and solve problems using physics concepts		X	
Carrying out activities to eliminate the misconceptions about the subject and prevent the occurrence of misconceptions.			X
Organizing activities that relate to other subjects of the physics course and sub-disciplines		X	
Measuring and evaluating in accordance with physics subjects and concepts		X	

Students are situated according to the traditional seating arrangement in the classroom. The classroom does not have a smart board. At the start of the class, the teacher sketched a wave model on the board. The teacher attempted to elicit a class debate on this paradigm by providing examples from everyday life. The teacher then defined the subject's concepts. The teacher questioned the students on these topics. The teacher seemed to be attempting to expose a difficulty scenario pertaining to the topic by the responses he got to these queries. The teacher called a student to the board and instructed the student on how to solve the issue. However, it was determined that the student was unable to provide the proper response. By posing certain questions to the whole class, the teacher attempted to offer students a chance to address the issue. It was noticed that students provided partly accurate responses to the teacher's queries. On the board, the teacher has solved the issue. The teacher then instructed the students to solve the issue by posing a question that was remarkably similar to the one he had solved. The teacher allowed students some time to work on the problem. At the conclusion of the period, the teacher called one of the students to the board and assisted him in resolving the problem.

It was noticed that the majority of students who attended the class in the start were very apathetic to it. The majority of students' desks lacked notebooks, papers, and pencils. It has been noticed that some students' interest in the class has risen as a consequence of the teacher using current events as examples and allowing students to talk throughout the session. However, several students remained apathetic to the lecture until the conclusion.

3.2. Data from Interviews with Teachers

After the lesson observations, the researcher interviewed the teachers. In these interviews, the opinions of the teachers regarding the deficiencies and needs for the implementation of the inquiry-based program in physics classes were taken.

Teachers in all three schools stated that students were less interested in physics lessons. SHS teacher PT1 stated that students are focused on the university exam. PT1 “As the university entrance exam questions were reduced, the interest in physics, chemistry, and biology courses decreased.” The TVHS teacher associated the PT3 students' disinterest in the lesson with their lack of goals and objectives.

The first question on the interview form is, “Do you see the necessity for in-service training in order to adapt to the advances in physics education (curriculum, techniques, etc.)?” Justify your position.” is included in the form. PT2 and PT3 teachers said, "There is a need," whereas PT1 responded, “There is no need.” Our teachers provided the following justifications for their responses:

PT1: *Not required. Only if new subjects are introduced, should they be seminar.*

PT2: *The approach includes targeted, purposeful actions, but how much will we give? It is beneficial to have constraints.*

PT3: *It would be good to be informed about what to tell and what not to tell. considered.*

The second section of the form asks, "Do you need in-service training in lesson preparation and delivery?" Kindly explain." is included in the form. PT3 said, “There is a need.” PT1 and PT2 teachers said, “There is no need.” Our teachers provided the following justifications for their responses:

PT3: *Everything would be OK but hard to use even the EBA (Educational Information Network). Because TVHS (students) are different from AHS and SHS students. I'm going to AHS for the course, the courses there are very different, I can go into more detail, but the subject here remains suspended.*

The third section of the interview form asks, "Do you need in-service training in teaching physics lesson topics and concepts?” Kindly explain.” is included in the form. PT3 said, “There is a need,” while PT1 and PT2 teachers responded, “There is no need.” Our teachers provided the following justifications for their responses:

PT3: *Maybe, at least it can provide a different perspective. Like atomic physics, that would be nice. Because there is different information in the lecture about quantum physics. It would be nice if they told us what they want us to tell.*

PT2: *I do not need. Our education is sufficient.*

Researcher: *What do you mean by the education we received? Undergraduate education?*

PT2: *Yes. In undergraduate, the education in the faculty of education is sufficient.*

The fourth option on the form is "Do you need in-service training on scientific knowledge pertaining to the physics curriculum's content?" Indicate which subjects are included in the form. PT1 responded, "There is a need," while PT2 and PT3 teachers said, "There is no need." Our teachers articulated their response and the topics for which they need in-service training sessions within the context of the physics curriculum as follows:

PT1: *This varies according on the topic's substance. There may be new physics courses introduced to the curriculum. As an example, consider particle physics. Dynamism is not comparable to electricity. In other words, contemporary topics such as lasers, advances in atomic physics, and astronomy.*

PT3: *I am not in need of it. However, we do have a physics group. There are 11-12. We have teachers who have never instructed students. This may work for them.*

The fifth question on the interview form is, "Do you need in-service training in innovative methods to learning and teaching (inquiry-based teaching, constructivist teaching, etc.)?". All teachers said, "There is a need," Our teachers shared the following perspectives on learning-teaching methods and instructional activities:

PT2: *I just attended a session on the approaches and strategies of teaching physics. It would be preferable if it were provided. Group work in particular proved beneficial. I attended a lecture on project-based educational approaches. It's very beneficial.*

Researcher: *How were the programs you participated in?*

PT2: *It was conducted in the manner of a seminar.*

Researcher: *Did you take part in any practices?*

PT2: *No, you have not completed the task.*

Researcher: *Have you had the chance to put the information and abilities you acquired throughout these trainings into practice in the classroom?*

PT2: *I am making an attempt to implement it, despite the fact that I am unable of doing it completely. Naturally, this is not always feasible, and some problems must be addressed. Applications are not accepted at this time.*

PT3: *Nothing to worry about. If there are other ways, it is preferable that I express it in this manner. That I am aware of. I got on-the-job training in innovative teaching approaches and strategies. In my classes, I attempted to incorporate many of the strategies we saw there. It had a significant impact. Students' interest in the class grew to the point that they really attended. I was taken aback as well. That is, it is possible.*

The sixth question on the form asks, "Do you need in-service training on teaching technologies, tools, and materials that may be utilized in physics instruction, as well as their use?". PT2 and PT3 teachers said "There is a need," while PT1 responded, "There is no need.". Our teachers shared the following perspectives on the use of instructional technology, tools, and resources in physics instruction:

PT1: *Students do not want to experiment. They see the experiment as a waste of time. Instead, they say they will solve so many questions. In fact, they are not so unfair; the conditions push the children to this.*

PT3: *This method is very effective. However, we must first get a substrate. Our school (TVHS) has many deficiencies in this area.*

Researcher: *Let's assume that equipment is provided.*

PT3: *It would be advantageous to have a guide in which I may do current tests.*

The form's seventh section asks, "Do you need in-service training on evaluating physics gains?". Our teachers offered the following sentiments on this subject:

PT2: *I attended a lecture on measuring and assessment. We included open-ended questions to the exams we created for students after this lecture. We included questions of the true-false, fill-in-the-blank, and branching tree kind. Returning to the standard questions.*

Researcher: *Do you evaluate your students?*

PT2: *Process assessment adds to the teacher's workload.*

Researcher: *If the required documentation for process assessment was provided in advance..*

PT2: *Because we do not know the student's level, this does not accurately represent the student's condition.*

PT3: *Perhaps, but not in high school initially. Children must use their creativity and self-expression. Our youngsters (TVHS students) are not used to comprehending texts.*

4. DISCUSSION and CONCLUSION

In the observations of AHS, SHS, and TVHS the data were interpreted together with the interview data. It has been observed that teachers in all classes have the following behaviors;

• Attracting attention at the entrance to the lesson, motivating the students to the lesson,

• Making a lesson plan, informing the students about the aims and achievements of the lesson,

• Explaining abstract concepts using concrete materials,

• Giving examples from daily life on the subject; using models,

• Organizing activities that relate to other subjects of the physics course and sub-disciplines,

• To make measurements and evaluations in accordance with the subjects and concepts of physics,

Since these points have been observed, it can be said that all teachers have mastered the lesson from the beginning to the end of the lesson. It can be said that teachers try to create an inquiry-based teaching environment by having classroom discussions. It is understood that classroom discussions are generally conducted over daily life examples and models.

All the teachers stated that the students were less interested in the physics lesson. The SHS teacher attributes this situation to the fact that students are focused on the university exam. It is understood from the SHS 11th grade observation data that the students are willing to participate in the lesson. It is thought that this situation is due to the fact that the subject of the course is related to the university exam. On the other hand, the TVHS teacher stated that her students did not even have the goal of entering university. It is understood from the observation data that TVHS students are reluctant to attend the lesson. The teacher attributed the TVSH students' indifference to the lesson to their lack of goals. The teacher associated the students' reluctance to participate in the lesson with this situation. Inquiry-based learning emphasizes active participation and responsibility for discovering knowledge that is new to the learner (De Jong & Van Joolingen, 1998).

Research indicates that teachers have difficulty motivating their students' learning interests (Chen et al., 2020). It was stated that demonstrations and hands-on activities could be used to increase students' situational interest (Lin, Hong, & Chen, 2013). It is emphasized that situational interest-inducing techniques such as demonstrations, models, analogies, discussion, and science games also cause a positive increase in students' individual interest in science (Palmer, Dixon & Archer, 2017). However, research indicates that teachers favor traditional techniques such as narrative and question-and-answer to create classroom settings (Ersoy & Dilber, 2015; Karal Eyüboğlu, 2011; Oğuz, 2005). It has been observed that teachers in all classes partially engage in the following behaviors;

• Conducting the teaching of physics subjects with the approaches-methods specified in the program,

• Implementing the teaching activities in current physics textbooks,

• Enabling students to pose and solve problems using physics concepts.

Capps and Crawford (2013) say that a teacher should have beliefs that are in line with reform-based ways of teaching and learning that go beyond their knowledge. All of the teachers said that they need new ways to learn and teach, like inquiry-based teaching and constructivist teaching. In light of the findings of the interviews with teachers, it can be concluded that teachers are willing to adhere to the aforementioned principles, but they only do so partly because of concern of spending too much time.

Technology can be useful in supporting inquiry-based learning, transforming classroom practices (Rubin, 1996), and solving real-world problems (Friesen & Scott, 2013). The use of instructional technology in topic presentation has been observed in the AHS classroom but not in the SHS or TVHS classes. However, an inspection conducted in a classroom at an AHS revealed that the smart board was being utilized only to show subject-related definitions and formulae. It can be concluded that the AHS teacher may improve the effectiveness of his presentations by using various apps to leverage instructional technology. It is assumed that teachers lack resources that include a variety of instructional technology tools.

Considering students' individual differences is vital to a good science education (Schlatter, Molenaar & Lazonder, 2020). SHS and TVHS teachers exhibited some of the behaviors associated with organizing learning activities that accommodated students' individual differences, fostering an environment in which students support one another's learning, and engaging in scientific process skills, but not AHS teachers. TVHS teacher demonstrated the conduct of establishing an atmosphere in which students organized their own learning, the SHS teacher demonstrated this behavior partly, and the AHS teacher demonstrated this behavior entirely. When we examine our teachers' involvement in in-service training, we find that AHS teachers participate at the greatest rate. In this context, it is thought that the AHS teacher's in-service trainings didn't help him enough.

It has been observed that teachers in all classes do not exhibit the following behaviors;

- Experimenting in the laboratory or conducting a demonstration experiment in the classroom,
- Organizing group learning activities,
- Carrying out activities to eliminate the misconceptions about the subject and prevent the occurrence of misconceptions.

Based on the teachers of the teacher interviews, it can be inferred that teachers at AHS and TVHS were unable to perform experiments due to a lack of supplies in the school's physics labs. In SHS, it may be inferred that students were unable to do experiments because they wanted to solve the exam rather than conduct the experiment and the teacher was unable to find time for laboratory preparation. This finding is consistent with the findings of Ersoy et al. (2018) study of eighteen physics teachers' interviews.

One of our teachers, who stated that she took an assessment-evaluation seminar in the interviews, stated that she applied what she learned in this seminar in her lessons. Observations in the twelfth grades of AHS and SHS revealed that teachings were transmitted via the creation of exam answers. On the other hand, inspections at TVHS' twelfth grade revealed that classes were conducted identically to those in the eleventh. When this scenario is assessed via interviews with teachers, it is believed that the student profile in schools and the students' future aspirations have a significant role in the development of the situation.

4.1. Suggestions

The learning process through scientific inquiry that actively engages students is more effective in increasing conceptual understanding than passive techniques used in standardized assessment (Minner et al., 2010). The assessment can vary, depending on the style of inquiry. One study says that science teachers should know what will happen if they choose more traditional ways of doing scientific research. It is stated that science educators should focus on making teaching environments relevant to the world their students live in (Kidman & Casinader, 2017). It is understood that the reasons behind pupils' lack of interest in physics lessons vary by school type. Based on these factors, it was established that vocational high school pupils do not have a university aspiration. It may be advantageous for these students to connect the concepts covered in physics classes to contemporary examples from the field of vocational education. In this setting, inquiry-based learning environments that cater to the interests of vocational high school, science high school, and Anatolian high school students can be created. In inquiry-based settings, it is felt that it would be good for high school science students to have content linked with college entrance exams.

It is believed that it will be beneficial to incorporate what needs to be done into the content of in-service training in order to avoid wasting time on using the approach-methods specified in the curriculum, implementing the teaching activities in physics textbooks, and enabling students to pose and solve problems.

It was noteworthy that the teachers gave almost the same examples on the subject and drew similar models. At this point, it can be said that teachers benefit from similar sources. It is thought that directing teachers in in-service training on how to use instructional technology tools would be helpful. It is believed that including experiments conducted using readily accessible materials into the curriculum of in-service training would be helpful. Preparing in-service training material for arranging group learning activities is considered to be helpful in this situation.

The findings of this research and the recommendations made will assist educators and administrators in planning and organizing in-service training activities, and it is hoped that they will shed light on the studies they will conduct in the context of eliminating deficiencies and improving in-service training activities for academicians working in the field of education.

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