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Analysing the problems of science teachers that they encounter while teaching physics education

Cihat Demir *, Faculty of Education, Dicle University, Diyarbakır, 21280, Turkey.
Burhan Sincar, Science Teacher, Diyarbakır, 2180, Turkey.
Rıdvan Çelik, Science Teacher, Diyarbakır, 21280, Turkey.

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Abstract

Even though physical science is very important in our daily lives, it is insufficiently understood by students. In order for students to get a better physical education, the teachers who have given physics lesson should first eliminated the problems that they face during the teaching process. The aim of this survey is to specify the matters encountered by science teachers during the teaching of physics and to provide them with solutions. The study group consisted of 50 science teachers who worked in Diyarbakır and Batman over the period of 2014 - 2015. This research is a descriptive study carried out by content analysis. In this study, semi-structured interview have been used along with qualitative research methods. According to the research findings, the top problems that the physics teachers encountered in physics lesson while processing the topics were laboratory problems. Some solutions have been introduced for science teachers in order to help them provide a better physics education.

Keywords: science teacher, physics education.

* ADDRESS FOR CORRESPONDENCE: **Cihat Demir,** Faculty of Education, Dicle University, Diyarbakir, 21280, Turkey.
E-mail address: cihat.demir@mynet.com

1. Introduction

Physical science is defined by MEB (2006) as science that tries to define and explain the physical and biological world. At the same time, science is a way of learning which is based on curiosity, creativity, intuition, inspection, imagination, observation, experience, interpretation of evidence and debating evidence and interpretation. Science does not occur from absolute and unchangeable knowledge. Instead, knowledge about science may progress and vary with new evidence obtained from new scientific research (MEB, 2005).

The main aim of science education is the definition of problems of a person's environment, by observing, setting hypotheses, making experiments, inference, analysis, generalisation, and the application of obtained knowledge and required skills. Hence, science is both a production and progression which influences every steps of life and includes parts of creativity (Saxena, 1994).

Physics has a very important place in the science education. Physics reflect our life more than other disciplines. Our walk, speech, travel; all become according to physical rules. Physics is the task of understanding the nature, learning reasons and the results of natural events and the expression of them using mathematical methods. Here, the purpose is to direct nature's becoming for the benefit of mankind. Physics is the sources of all the natural sciences and all the branches of engineering using the principles of the physics. So many of the situations that we face, we use and that we observe in our daily lives are related to physics. Physics enters into the lives of the students so much that wherever you go in the world, living beings, earth, sky, air, water, light and gravity always constitute inseparable parts of the environment of the students (Aycan & Yumusak, 2003).

Anderson (2003) suggests that effective scientific practice have substantial features, made up of three major parts: science knowledge and practice; sense-making strategies; and scientific habits of mind.

1. *Science Knowledge and Scientific Practice.* Science knowledge consists of a substantial number of three types of knowledge claims: experiences, patterns, and models. It is essential to distinguish these types of knowledge. *Experiences* refer to observations created through interactions with the objects, systems and the phenomena of the material world. Scientific data are recorded experiences that meet criteria for accuracy and reproducibility. *Patterns in experience* refer to data displays such as charts and graphs; such as verbal or mathematical expressions of patterns in experience like generalisations and scientific laws. *Theories and models* refer to systematic explanations of patterns in experience or data that apply to all data in a domain and can be tested against new data.

   Scientific practices consist of application and inquiry. Application means using scientific models to describe, explain and predict experiences in their domain, and to design systems or strategies for controlling objects, systems and phenomena in the material world. Inquiry means using arguments from evidence to find patterns in experience and create explanatory models.

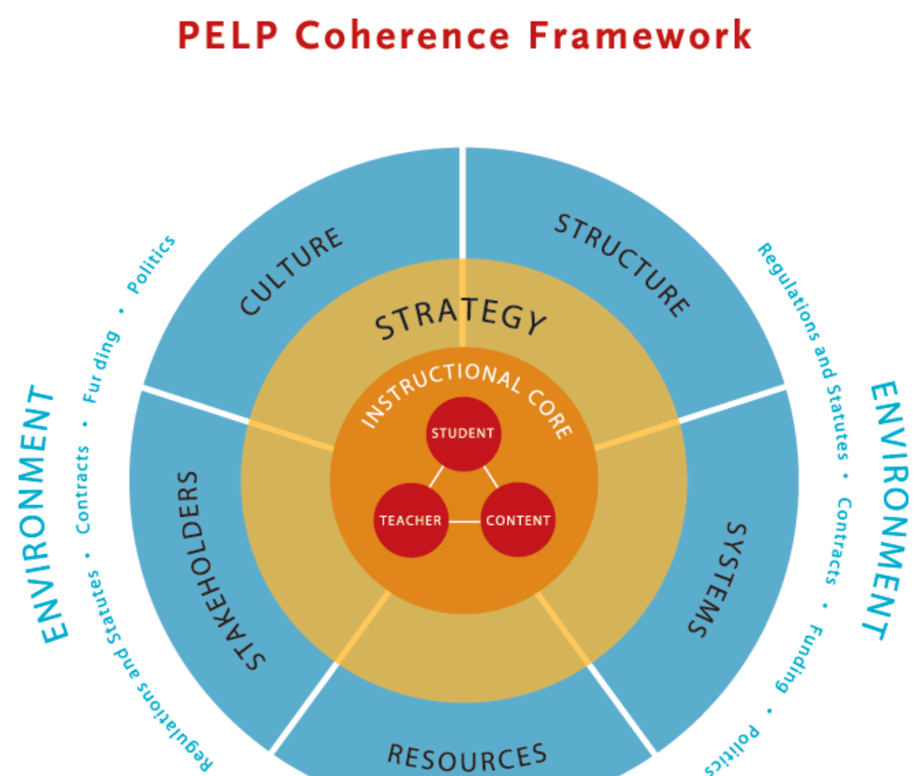
2. *Sense-making strategies.* Different sense-making strategies are used when we attempt to understand the scientific world. *Procedural display* refers to the production of correct answers by following memorised procedures. *Practical reasoning* (craft knowledge) refers to achieving practical results through reasoning that is action-oriented, person- and context-bound, tacit, integrated and based on beliefs. *Narrative reasoning* is used to make sense of the world in terms of linked, linear sequences of events. This strategy is used to engage narrative explanations of systems and phenomena in the material world. *Model-based reasoning* refers to developing and using explicit models or theories that account for phenomena within a domain of applicability; this strategy is used to make sense of the scientific world.

3. *Scientific habits of mind: curiosity and rigor.* Engagement in scientific practice involves *curiosity* about the scientist's natural environments and *rigor* in their reasoning to make sense of the material world.

Teachers who are certainly responsible for organising learning media also make the most important contribution to students in helping them to understand physics well.

An efficient science teacher must have these skills:

1. Develop a language of communication which enables students to acquire comprehensible content and interact with science materials;
2. Keep balance between oral, written and applied science activities;
3. Create an active learning environment for students;
4. Plan and order learning processes;
5. Monitor and evaluate students' academic development with proper measurement techniques;
6. Teach individual and small groups;
7. Encourage students to ask "How?", "Why?" and "What if?" questions;
8. Motivate students to determine solutions (by examining cause and effect relation);
9. Plan experimental studies and study in a safe laboratory environment;
10. Relate science subjects taught in the classroom with natural events out of the classroom (YOK/World Bank, 1997).



Graphic: The place of the teacher in the education system.
http://education.ky.gov/curriculum/standards/teachtools/Documents/ScienceResearch.pdf

To make science teachers useful for the students, it is necessary to bring out the problems of physics education and approach how the problems should be overcome. A science teacher who faces up to these problems could become more useful to his or her students. In this way, they could gain maximum benefit from the teacher factor which is the one of the factors that influence learning.

2. Purpose of the Research

The purpose of this research is to determine the problems that science teachers face when teaching the subject of physics. In the orientation of this research, the answers of the questions below are hence provided.

3. Method

This study has been conducted using the qualitative research tradition. Qualitative research methods are being used more and more in research on social matters (Patton, 2002). Data has been collected using open-ended questions. Open-ended questions thus allow the researcher to deal with the data that s/he desires to examine in a flexible and unlimited way (Yildirim & Simsek, 2000). Thus, without sticking to the pre-determined survey categories, the researcher will be able to obtain direct points of view about the experiences, thoughts, emotions and information of the people studied (Patton, 2002).

4. Study Group

The study group consists of 50 science teachers working at state schools in the Diyarbakır and Batman provinces over the 2014-2015 period.

5. Data Collection and Analysis

A questionnaire consisting of open-ended questions has been developed to collect data. In order to develop this questionnaire, firstly the studies on the subject matters have been examined, while meetings and discussions have been held with science teachers and academicians, and a question pool of 10 questions has been created. We have worked together with academics on the wording of these questions, and the order and content thereof, while the number of questions has been reduced to 5 questions. A pilot study has been conducted with 10 science teachers.

Following the pilot study, the questionnaire has been finalised by applying amendments and alterations to the questionnaire in line with the critics and recommendations of science teachers as well as the opinions of the academics. For the purpose of validating these research questions, we sought the opinions of three academics in total, two associate professors and one assistant professor from Dicle University, Ziya Gokalp Faculty of Education on the extent to which the science teachers represent the problems they face in physics training.

The research questions consisted of questions intended to examine and research the problems faced in teaching the subject of physics in science lessons, the contribution of theoretical physics lessons to undergraduate study of physics, the contribution provided by "special teaching methods" taught in the undergraduate study to the physics subjects, special teaching methods and techniques used by most of the science teachers in teaching physics training and how science teachers will be educated in undergraduate study. The data was collected by the researchers during October 2014 - February 2015. The analysis of the data collected is based on the "data reduction", "data display" and "conclusion verifying" approach of Miles and Huberman (1994).

Firstly, the written answers to the questions have been gathered in the computer environment to develop study data. Using the content analysis, the data has been categorised by means of coding at conceptual and relational levels. Data analysis has been performed separately by researchers. The categories have been determined with the agreement of researchers on the categories used. Efforts were used to ensure that the categories have integrity, are integral and distinctive and are presented and interpreted in an understandable manner (Miles & Huberman, 1994; Strauss & Corbin, 1998; Yildirim & Simsek, 2000).

Participation frequency has been calculated for the categories. Reliability was determined through the agreement of inter-coders based on the use of many coders in data analysis (Creswell, 2007). In this study, for the purposes of increasing objectivity and ensuring reliability in the analysis, reference was made to the correspondence of codes in the coding of the first and last question for the reliability of the researchers performing the coding. The correspondence percentage has been calculated using the following formula: (number of all corresponding categories) / (number of all corresponding and non-corresponding categories) (Miles & Huberman, 1994). The reliability coefficient was found to be 0.83 for the question "What are the problems you face in teaching the physics subjects in science lessons?", and was found as 0.82 for the question "What kind of a physics training can be given to science teachers in their undergraduate study?" These figures were considered sufficient for the coding reliability of the study.

6. Findings

In this section, the findings obtained are provided together with the participation frequency of the participants according to categories outlined in a detailed way based on the categories agreed after the analysis.

6.1. Findings Relating to the Problems Faced in Teaching Physics Subjects in Science Lessons

Table 1. The Problems Faced in Teaching the Physics Subjects in Science Lessons

The Problems Faced in Teaching the Physics Subjects in Science Lessons	f	%
Lack of laboratory and laboratory materials	27	54
Inability to go down to the student level due to the fact that subjects and concepts are abstract	20	40
The reflection of poor math's level of the students on the science lesson	12	24
Poor arrangement of the content of the lesson book	6	12
High population of classes	2	4

54% of the science teachers participating in the study complain about the lack of laboratories and laboratory materials. A science teacher explains this situation as follows:

"I am having difficulty in embodying the subject matter due to the lack of laboratory materials". Participant 13

40% of the teachers stated that they are unable to go down to the student level due to the fact that subjects and concepts are abstract.

Note: In some of the tables, frequency and percentage values are higher than the number of participants; this is because the participants shared multiple opinions.

6.2. Findings Relating to the Contribution Provided by Theoretical Physics Lessons Taught to Teachers during their Undergraduate Education to the Physics Subjects in Science Classes

Table 2. Opinions of the Teachers about the Contribution Provided by Theoretical Physics Lessons Taught to Teachers during their Undergraduate Education to the Physics Subjects in Science Classes

The Contribution Provided by Theoretical Physics Lessons Taught to Teachers during their Undergraduate Education to the Physics Subjects in Science Classes	f	%
Not sufficient	23	46
Partially sufficient	22	44
Sufficient	5	10

46% of the participant teachers stated that the contribution provided by theoretical lessons they were taught during their undergraduate education to the physics subjects in theoretical science lessons are not sufficient. While 44% of the participant teachers stated that the contribution is partially sufficient since upper level physics matters are taught, 10% of the participant teachers stated that theoretical physics lessons they were taught during their undergraduate study were sufficient.

6.3. Findings Relating to the Contribution of "Special Teaching Methods" Taught During the Undergraduate Study to the Teachers in Teaching Physics Subjects

Table 3. Findings relating to the contribution of "special teaching methods" taught during the undergraduate study to the teachers in their teaching physics subjects

Contribution of "Special Teaching Methods" Taught During the Undergraduate Study to the Teachers in Teaching Physics Subjects	f	%
Not sufficient	23	46
Sufficient	10	20
Partially sufficient	17	33

46% of the participant teachers stated that the special teaching methods did not provide sufficient contribution to teachers in teaching the physics subjects, 33% of them stated that it was partially sufficient and 20% of the participant teachers stated that special teaching methods did provide sufficient contribution to teachers in teaching the physics subjects.

6.4. Findings Relating to the Special Teaching Methods or Techniques used the most by Teachers when teaching Physics

Table 4. Findings relating to the Special Teaching Methods or Techniques Used the Most by the Teachers in Teaching Physics

Special Tea Ching Methods Or Techniques Used The Most By The Teachers	F	%
Lecturing	25	50
Question-Answer	25	50
Experimenting	13	26
Show and Ask for Practicing	12	24
Demonstration	10	20
Finding	10	20
Brainstorming	7	14
Problem Solving	7	14
Six Thinking Hats	3	6
Research, Analysis	3	6
Simulation	2	6
5E (constructivism)	1	2

50% of the participant teachers stated that they used the Lecturing and Question-Answer technique; 26% of them stated that they used Experimenting, 24% of them stated they used Show and Ask for Practicing; 20% of them stated they used the Demonstration and Finding technique; 14% of the participant teachers stated that they used the Brainstorming and Problem solving technique; 6% of them stated that they used Six Thinking Hats, Research, Analysis and Simulation technique; and 2% of them stated that they used the 5E technique.

6.5. Findings Relating to What Teachers Think about What kind of a Physics Training should be Given to Science Teachers during the Undergraduate Study

Table 5. Findings Relating to What Teachers Think about What Kind of Physics Training should be given to Science Teachers during Undergraduate Study

What Teachers Think about What kind of a Physics Training should be Given to Science Teachers during Undergraduate Study	f	%
The experiments that should be conducted during secondary school should be made available to all students and laboratory lessons should be provided effectively each year	43	86
A physics training in accord with the secondary school science syllabus should be provided	18	36
A physics training with a high teaching practice should be provided	3	6

While 86% of the participant teachers stated that the experiments that should be conducted during the secondary school should be made available to all students and that laboratory lessons should be provided effectively each year, 36% of the participant teachers stated that a physics training in accord with the secondary school science syllabus should be provided.

6.6. Findings relating to the Opinions of Teachers for Ensuring that Science Teachers can Give a Better Physics Training

Table 6. Findings relating to the Opinions of Teachers for Ensuring that Science Teachers can provide Better Physics Training

The Opinions of Teachers for Ensuring that Science Teachers can Give a Better Physics Training	f	%
Fully-equipped laboratories must be available - and training should be provided for improving the skills of using laboratory tools-equipment and materials	45	90
Class populations should be optimised	5	10
Applied on-the-job training should be provided to science teachers	3	6
Science teachers must graduate from undergraduate study as fully equipped on physics subjects	8	16
Tour-observation studies and activities	2	4

A great majority of the participant teachers - that is 90 % - emphasised the need for fully equipped laboratories. A teacher explains this situation as follows:

"*Laboratories at each school must be provided with all necessary materials.*" Participant 18

16% of the teachers stated that science teachers must graduate from undergraduate study fully equipped with physics subjects.

7. Discussion and Conclusion

The early problems of science teachers were encountered while processing physics laboratory problems (54%). A majority of 90% of the teachers who participated in the study also said that there should be fully equipped laboratories for science teachers in order to give them a better physics education. 86% of the teachers participating to this study asked how the science teachers should be trained and their answer was that the testing performed in secondary school should be done every effectively every year. People have used many methods and techniques to achieve their goals today as in the past and they have developed many methods to provide the best education. One of these methods involves experimental studies performed in the laboratory which are so effective in physics education (Lawson, 1995). The best way of learning is by doing and experiencing actions and results.

Due to students' involvement in activities based on learning by experience, creating a laboratory environment laboratory is an integral part of science teaching (Ayas, Cepni & Akdeniz 1994). In regard to physics topics, the students in physics teaching may encounter at every stage of life the learning that has made it necessary for them to gain the expected behaviour change accompanying the use of applications in laboratories (Akdeniz and Karamustafaoglu, 2003). There is therefore an important role for laboratories in physics teaching.

The laboratory is the environment where students have gained their first-hand experiences and, through their own experiments, they learn concepts and laws on the basis of the environment (Cilenti, 1985). The science that makes effective education involves infrastructure, laboratories and other units as a suitable practitioner training model and the model employed by teachers. If any of these factors are lacking then they will affect the education system adversely (Morgil & Yılmaz, 1999). 46% of the science teachers who participated in the study explained that the theoretical physics course in the science of physics topics in which they had been trained at university were insufficient. Physics teachers should instead make a connection between the real world and physics. Teachers need to think broadly about how the real world and the information obtained in the study of physics are connected to each other (Ozek, 1997).

The majority of science teachers participating in the study also said that special education methods courses in which they had been trained in the license were insufficient. According to Garmston (1988), professional teachers should instead be required: to have strong knowledge; to know the right teaching materials; to decide which topics which will be more effective in teaching methods; to have a knowledge and understanding of child development and learning theory; to be sensitive about learning styles of the students in the classroom; to have a good understanding of the norms and values that determine whether he is weak and strong; to have healthy communication and good interaction with his colleagues. When viewed as a whole, the problems they encounter in the physical science teacher education are laboratory teacher-centred issues have been coming.

These problems include selecting teachers and training prospective teachers in the correct methodology, while teachers' in-service teacher training includes items such as self-development. Teachers will see their role different if they put themselves in their students' shoes when approaching science/physics problems. First of all, they will see the mistakes of the teachers that they don't give the students any chance to express their feelings and thoughts. Crowded classrooms is one of the factors that makes education difficult (Yalcin, 1999).

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