Prospective Teachers' Views on Teaching Science Concepts

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Received: March 4, 2024 Accepted: April 15, 2024 Online Published: May 24, 2024

doi:10.5430/wje.v14n2p37 URL: https://doi.org/10.5430/wje.v14n2p37

Abstract

This study aims to investigate the views of pre-service teachers who have taken the "Science Teaching" course in the undergraduate program of classroom teaching about the teaching of science concepts. In this study, the phenomenology study approach, one of the qualitative research designs, was used. The study group of this research consisted 75 pre-service teachers, 56 female and 19 male, studying in the third year of the undergraduate primary teaching program of a state university. In this study, the views of the pre-service teachers who took the science teaching course about the teaching of science concepts were determined through four open-ended questions followed by face-to-face semi-structured interviews with eight participants. It can be said that the idea that prototype examples should be given about a concept in concept teaching is known by pre-service teachers (82.3%). It was observed that the pre-service teachers were aware of a misconception about force as a science concept (90.7%), but they had difficulty writing the main views of learning theories (48.0%). It is an important detail that the participants did not see the exams as tools to eliminate misconceptions at a high rate (82.7%). Interviews were conducted with eight participants who volunteered and had available time about the answers they wrote for four open-ended questions. It was seen that the participants' opinions supported the findings of this study. Some suggestions were made based on the findings of the study.

Keywords: teaching science concepts, pre-service teachers' views, phenomenology

1. Introduction

1.1 Problem and related literature

It is widely accepted that children always have preconceived ideas that influence their thinking about any topic. In line with this acceptance, we are particularly interested in situations, phenomena, and events in which children have immutable ideas that differ from those of scientists (Osborne, 1995, p. 47). Teachers' efforts should enable students to modify their alternative ideas in accordance with the views of scientists (Hewson, 1981), construct a scientific framework (West, 1982), or have an additional perspective linked to their initial ideas (Solomon, 1983). Teachers need to be aware of how students can acquire new non-scientific ideas in the classroom because of the alternative ideas they have about science topics (Hashweh, 1988; Stepans et al., 1970; Watts, 1983). Examples used to explain a concept in a lesson or the classroom can sometimes convey a completely different meaning to students and lead to the actual outcome being different from what was intended (Anderson, 1986; Berg & Brouwer, 1991).

Watts & Zylbersztajn (1981) found that teachers were not adequate in predicting students' ideas about concepts and quantities in science lessons. Osborne et al. (1983) found that teachers were largely unaware of students' thinking and were generally not sensitive to the views that students brought to science lessons. Teachers' knowledge of students' alternative ideas and preferred teaching strategies is important for students who perceive science as a difficult subject to learn, as they can provide supportive explanations to overcome these difficulties (Berg & Brouwer, 1991). The view that force is concentrated in a body and acts in the direction of motion is a common view advocated by the 14th century Parisian physicists, led by Buridan. It is stated that Buridan's view is still widely accepted among secondary school students and is generally not influenced by the scientific ideas of science teachers (Osborne, 1995, p. 46; Yıldız, 2022a).

People learn their mother tongue in the shortest time and most permanent way (Rancière, 2016, p. 13). Despite this

advantage, the subject of language is difficult and complex. It is stated that weight instead of mass, speed instead of velocity, path instead of displacement, power instead of force, dissolution instead of dissolution, and investigation instead of research are commonly used in daily conversations (Yıldız, 2014; 2017a; b; c; 2018a; b; 2020; 2021). In general, students use the language that makes sense to students and teachers use the language that makes sense to teachers. The language that is meaningful to teachers may evoke completely different meanings in students due to the experiences they have gained in their lives. The language that students find meaningful may be different from the language used and spoken in scientific documents, meetings and classrooms. If no precautions are taken and this situation is left unattended, conceptual change may not occur (Gunstone & Watts, 1985), and even new misconceptions may be formed.

In fairy tales, legends, cartoons, and fictional and made-up activities, misconceptions may occur due to non-scientific situations. In a document (Miandji, 2020, p. 72, p. 127), the importance of imagination is stated as "The greatest power is imagination." and "Imagination makes a person grow." The period when children listen to or read fairy tales and watch cartoons is a period when their imagination is at its peak. The imaginations formed with the influence of the fairy tales learned and cartoons watched in this period may lead children to acquire new misconceptions in many subjects or to the permanence of the acquired misconceptions (Yıldız, 2022a).

Science teachers should be aware that students may have preconceptions on every subject, that subjects should not be passed over superficially, that documents used in lessons may contain misconceptions, that the difference between spoken language and scientific language causes problems, and that non-scientific beliefs have negative effects (Yıldız, 2022a). As stated in a study (Posner et al., 1982), students need to realize that their current thoughts are not sufficient before they can change their thoughts. In the same study, it is emphasized that the new idea should be understandable, logical and useful for conceptual change. In other words, for conceptual change to take place, the new scientific idea presented must have these three qualities. After the appropriate conditions for conceptual change are provided, it may take a longer time than expected for students to replace their misconceptions with scientific ideas. It would be useful and appropriate for science teachers to act patiently, consistently and tolerantly in this conceptual change process and to show the understanding that it is a situation that will occur over time (Yıldız, 2022a).

Initial learning is important because new concepts and quantities to be learned are constructed in the mind by building on or associating with previously learned ones (Ausubel, 1968). Erroneous or unscientific learning in primary school may prevent subsequent learning from being at a scientific level. It is stated that the causes of misconceptions in science can be categorized under five headings, and one of these headings is "misconceptions that are present in textbooks, teachers and passed on to students in the classroom environment" (Yıldız, 2022a, p. 214). It is predicted that prospective teachers who know the teaching of science concepts well will be able to realize a science teaching that will not cause misconceptions.

1.2 Purpose of this study

This study aims to investigate the views of pre-service teachers who have taken the "Science Teaching" course in the undergraduate program of classroom teaching about the teaching of science concepts.

2. Method

2.1 Study Design

In this study, phenomenology study approach, one of the qualitative research designs, was used. In phenomenology research, data sources are individuals or groups who experience the phenomenon that the research focuses on and who can express or reflect it (Yıldırım & Şimşek, 2018, p. 71). As in many qualitative studies, purposeful sampling methods are used in phenomenology studies (Yıldırım & Şimşek, 2018, p. 118). In this study, critical case sampling, one of the purposeful sampling types, was used to reveal the views of pre-service primary school teachers about the teaching of science concepts (Yıldırım & Şimşek, 2018, p. 121). Critical case sampling is used when a researcher or observer makes a determination or inference, such as "If this group is having problems, we can be sure that all other groups are also having problems" (Patton, 2014, p. 236).

2.2 Study Group

The study group of the present research consisted of 75 pre-service teachers, 56 female, and 19 male, studying in the third year of the undergraduate primary teaching program of a state university in the fall semester of the 2023-2024 academic year. The sample selection was influenced by the "Science Teaching" course, which aims to provide

pre-service teachers with knowledge and skills about teaching science concepts, which was taken before this study. Therefore, pre-service classroom teachers studying in the fifth semester were preferred.

2.3 Data Collection

In this study, an opinion form with four open-ended questions about the teaching of science concepts prepared by the researcher was used as a data collection tool. As stated in a document (Büyüköztürk et al., 2013), the content validity of the four open-ended questions was supported by taking the opinions of experts in the field. To make the open-ended questions in the interview form understandable, necessary corrections were made in line with the feedback received from the experts. Before the opinion form was applied within the framework of the principle of voluntariness, explanations were made to increase the motivation of the study group. The researcher stated that the answers the participants would write with a sincere understanding to the open-ended questions in the opinion form could provide crucial data for their research and were therefore valuable. In other words, the researcher tried to minimize the situations that prevented the flow of data by stating that they needed the opinions and thoughts of the pre-service classroom teachers about the teaching of science concepts. The pre-service teachers wrote and answered four open-ended questions under the researcher's control and in the classroom environment.

In phenomenology research, second or third interviews can be conducted. Such interviews increase the validity and reliability of the research as they provide the opportunity to confirm the explanations and meanings reached by the researcher to the interviewees (Yıldırım & Şimşek, 2018, p. 71). In this context, semi-structured interviews were conducted in the researcher's office with eight volunteer and time-appropriate participants about the answers they wrote for four open-ended questions. No video or audio recording device was used during the interview process. In the interviews, the participants' opinions were determined based on the statements and explanations written and recorded by the researcher himself. At the end of each face-to-face interview, the written versions of the opinions and thoughts were reviewed. The missing or incorrectly written statements were immediately confirmed, and necessary corrections were made. The views of four participants, which were considered interesting among the views put forward by the eight participants interviewed, are presented in the findings section under the relevant heading.

2.4 Data Analysis

All qualitative research reports are based on description (Patton, 2014, p. 438). The best advice for researchers is to read and analyze the data they collect over and over again. The more the data are scrutinized, the more patterns and categories begin to appear to the researcher (Patton, 2014, p. 446). Based on this claim, the descriptive analysis method was used to organize the data obtained. In the descriptive analysis method, the data are brought together in a meaningful and logical way, organized and defined in an understandable way (Yıldırım & Şimşek, 2018). Subsequently, the findings are interpreted by making the necessary inferences.

In this study, the answers written by pre-service teachers for each open-ended question were analyzed in detail. Given the similarities of the answers, they were grouped under certain categories. The categories were re-examined, and the grouped expressions with common and similar meanings were re-combined. The grouped answers of the participant pre-service teachers, the number of female, male and total participants who wrote the answers and their percentages were transferred to the relevant tables prepared separately for each question. After each table, the inferences and comments made about the grouped statements of the participant pre-service teachers were included.

In the semi-structured interviews conducted with the pre-service teachers, four opinions, which are considered to be different and interesting among the opinions of eight participants, which were determined based on the statements and explanations written and recorded by the researcher, are presented in the findings section under a separate subheading.

3. Results

This study aims to reveal the views of pre-service teachers who have taken the "Science Teaching" course, which sets out to provide knowledge and skills related to the teaching of science subjects in the undergraduate program of primary school teaching, on the teaching of science concepts. For this purpose, the data collected with four open-ended questions directed to the participants were analyzed and transferred to the relevant tables.

Question 1. Can you write an incorrect or inaccurate statement about Science Concepts?

Table 1. Pre-service Teachers' Answers to the First Question

Pre-service teachers' answers	Male	Female	Total	%
Concepts should be taught with the best examples that represent them	-	1	1	1.3
Penguin and ostrich are prototypical (first, best) examples of the concept of a bird	15	47	62	82.3
Concepts are abstract units of thought	3	1	4	5.3
"Gases have no mass" is one of the common misconceptions in the field of science	-	4	4	5.3
A concept can be defined as a common name given to a group of events, phenomena, ideas and objects with similar characteristics.	1	3	4	5.3
Total	19	56	75	100

When the answers of the prospective teachers for the first question were analyzed, it was seen that 82.3% of them wrote the incorrect statement. In fact, in questions used as measurement and evaluation tools, it is generally not required to write incorrect or inaccurate statements. In general, scientifically correct features, qualifications, or definitions are requested. In other words, it is a question that the participants are not accustomed to since false or incorrect information is not asked or discussed in written and oral exams, meetings, presentations and discussions. Thus, it is thought that pre-service teachers may have had difficulty. In a study (Yıldız, 2022b) conducted on the level of pre-service teachers' understanding of concepts related to light, an opinion supporting this claim was put forward. The statement in the last line is actually a frequently used and accepted definition for the concept. It is interesting that the definition of the concept was written as an erroneous opinion by four participants.

Question 2. In an order of paradigm, theory, scientific law, misconception and principle, for which statement "If an object is not moving, there is no force acting on it" can be an example?

Table 2. Preservice Teachers' Answers to the Second Question

Pre-service teachers' answers	Male	Female	Total	%
Paradigm	-	-	-	-
Theory	1	3	4	5.3
Scientific law	2	1	3	4.0
Misconception	16	52	68	90.7
Principle	-	-	-	-
Total	19	56	75	100

The second question is about a misconception about force, which is generally known by science and physics teachers and common among students (Yıldız, 2006; Güneş, 2017). It is seen that 90.7% of the pre-service teachers are aware of this misconception about force. However, it is an important detail that there were participants who accepted the statement "If an object is not moving, there is no force acting on it" as a theory (5.3%) and a law (4.0%).

Question 3. Which of the scientists listed as David Ausubel, Niels Bohr, Jerome Bruner, Robert Gagné and Jean Piaget can be attributed to the idea that "The most important factor affecting learning is the existing knowledge of the student, this should be revealed and teaching should be planned accordingly."?

Table 3. Pre-service Teachers' Answers to the Third Question

Pre-service teachers' answers	Male	Female	Total	%
David Ausubel	11	25	36	48.0
Niels Bohr	-	-	-	-
Jerome Bruner	3	13	16	21.3
Robert Gagné	2	7	9	12.0
Jean Piaget	3	11	14	18.7
Total	19	56	75	100

Except for Niels Bohr, all other scientists have conducted insightful studies on education. Each of them has different views and theories about learning. Niels Bohr is a famous scientist who received the Nobel Prize in Physics in 1922. It is pleasing and important that all the participants know that Bohr's thought "The most important factor affecting learning is the student's existing knowledge, this should be revealed and teaching should be planned accordingly" does not belong to Bohr. This idea belongs to Ausubel (1968). It is not coincidental that 48.0% of the pre-service teachers answered David Ausubel. However, the fact that the participants chose Bruner 21.3%, Gagné 12.0% and Piaget 18.7% are answers that need to be considered and discussed.

Question 4. Which tools listed as analogies and explanatory models, concept maps, exams, computer assisted instruction and concept modification texts are not used to realize conceptual change?

Table 4. Pre-service Teachers' Answers to the Fourth Question

Pre-service teachers' answers	Male	Female	Total	%
Analogies and explanatory models	-	1	1	1.3
Concept maps	-	-	-	-
Exams/tests	14	48	62	82.7
Computer-aided education	3	7	10	13.3
Concept change texts	2	-	2	2.7
Total	19	56	75	100

The detection of misconceptions is a difficult process, but their elimination is much more difficult and requires a long time (Güneş, 2017; Yıldız, 2022a). Therefore, various tools are used by teachers to eliminate misconceptions. Written and oral exams are not used as a means of eliminating misconceptions. This point is especially emphasized in the teaching of concepts. It is an important finding that 82.7% of the participants do not see exams as tools that provide conceptual transformation. Another important finding is that none of the participants wrote concept maps in response to the fourth question. This finding proves that the entire study group is aware that concept maps are one of the tools used in the conceptual change process. Based on this argument, it can be inferred that the participants know that concept maps can be used in learning concepts, identifying misconceptions, eliminating misconceptions, and measurement and evaluation processes related to concepts.

Opinions expressed in the interviews with the participant pre-service teachers

Face-to-face semi-structured interviews were conducted by the researcher with eight volunteer and time-available participants about their answers to four open-ended questions. Among the views put forward by the eight interviewed participants, four views that are considered different and interesting are presented below.

In everyday life, we often use inaccurate or unscientific statements. However, in lectures, class discussions and exams, we are usually asked to know the correct or scientific information. In short, writing an erroneous statement was a situation I was not used to; I can say that I had a lot of difficulty.

I knew that the statement in the second question was a very common misconception about force among primary school children, so I wrote it down.

Ausubel, Bruner, Gagné and Piaget are all theoreticians, that is, scientists with views on learning. I do not remember that Bohr had a study or claim about learning. I know that Piaget associates learning with periodicity, that is, age. I thought the statement asked in the third question could belong to Bruner, and I wrote it down. However, I searched later because I was curious, I was wrong, and I saw that it belonged to Ausubel.

I remember that we talked and discussed a lot about the identification and elimination of misconceptions in the science teaching course. I think I learned this topic well. Therefore, I had no difficulty writing the answer to the fourth question.

4. Discussion

The answers written by the participants to the open-ended questions of the present study were descriptively analyzed and transferred to the relevant tables. It can be said that the idea that the first examples related to a concept are important in teaching concepts and that examples showing all the features of the concept should be given in general

is known by pre-service teachers (82.3%). Each concept may have exceptions. However, it is important to know and apply the knowledge that one should avoid using exceptions in the process of giving the first examples of the concept. It can be claimed that in the science teaching course, pre-service teachers were aware of a misconception (90.7%) about force, which is a science-related quantity. In the studies (Güneş, 2017; Yıldız, 2006), it is emphasized that the statement "If an object is not moving, there is no force acting on it" is a common misconception about force. Ausubel's (1968) idea that "The most important factor affecting learning is the current knowledge of the student, this should be revealed and teaching should be planned accordingly" (Özmen, 2004, p.102). It was observed that the pre-service teachers had a low rate (48.0%) of knowing which scientist belongs to this frequently emphasized idea that they generally benefit from in the process of learning the concepts and that they had hesitations (52.0%) at the point of knowing it correctly. It is an important detail that the participants did not see exams as tools that eliminate misconceptions at a high rate (82.7%). It was found remarkable that all of the pre-service primary school teachers recognized concept maps as the tools used in eliminating misconceptions because concept maps are tools that are utilized at multiple stages in the concept teaching process. Concept maps can be used in learning concepts, determining misconceptions, eliminating misconceptions and measurement and evaluation processes related to concepts.

According to the opinions revealed in face-to-face interviews, it was observed that the participants had difficulty writing an erroneous statement about a concept and the main ideas of learning theories. This view of a participant who stated that they had difficulty writing an erroneous statement about a concept or quantity is similar to and supports the view of a participant in another study (Yıldız, 2022b).

Motivating pre-service teachers about teaching science concepts can make them active participants in the learning process. Appropriate and effective motivation can enable pre-service teachers to directly participate in the discussions about teaching science concepts in the science teaching course and express their opinions. These discussions in the classroom can even increase communication among peers. Then, it can evolve into peer teaching. Mazur (2019) stated that students can explain concepts to each other better than teachers. Therefore, the teaching of science concepts should be supported by explanations and in-class discussions that motivate pre-service teachers by using understandable language.

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Acknowledgments

Not applicable.

Authors contributions

Not applicable.

Funding

Not applicable.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Sciedu Press.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.