Pre-Service Teachers' Levels of Understanding the Light-Related Concepts

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Abstract

The aim of the study is to investigate the level of understanding of light-related concepts of teacher candidates who took the “Basic Science in Primary School” course in the classroom teaching undergraduate program. This research is a descriptive study. The study group consists of 65 teacher candidates, 51 female, and 14 male studying in the first year of the classroom teaching undergraduate program at a state university. In the study, an opinion form containing five open-ended questions prepared by the researcher was used as the data collection tool. The grouped answers of the teacher candidates, and their background knowledge were calculated and separately transferred to the relevant tables for each question. For each table, the inferences, and comments about the grouped expressions of the participant teacher candidates have been provided. In addition, interviews were conducted with six randomly selected participants. It has been revealed that the pre-service teachers' scientific knowledge about the concepts related to the light is not at the desired level. Based on the findings of the study, some suggestions were made.

Keywords: light, pre-service teachers, level of understanding

1. Introduction

1.1 Introduce the Problem

The assumption that children always have preliminary ideas that affect their thoughts on any subject has been accepted. In line with this acceptance, particularly children are interested in situations and events in which they have stable thoughts different from scientists (Osborne, 1995, p. 47). Efforts of teachers should be in the direction of enabling students to change their alternative thoughts in accordance with the views of scientists (Hewson, 1981), to create a more scientific framework (West, 1982), or to have an additional perspective related to their first thoughts (Solomon, 1983). The view that the force is concentrated in a body and acts in the direction of motion is a common view advocated by the 14th century Paris physicists led by Buridan. It is stated that this Buridan view is still widely accepted among secondary school students and is not affected by the scientific thoughts of science teachers (Osborne, 1995, p. 46).

In Watts and Zylbersztajn’s study (1981), it is stated that it is not possible for science teachers to know or be aware of, or even predict, all the alternative thoughts that students in their classrooms have about science subjects. Osborne, Bell, and Gilbert (1983) found that teachers are largely unaware of students' thoughts and are generally inattentive to the views students bring to science lessons. It was seen that Anderson and Smith (1985) reached similar results in their research with the fifth-grade teachers. The results of the studies show that students have alternative thoughts about difficult physics subjects. Teachers' knowledge of students' alternative thoughts and preferred teaching strategies; students who see physics as a difficult subject to learn can overcome this difficulty (Berg & Brouwer, 1991).

It has been stated that primary school students have misconceptions about light and these misconceptions are generally the result of their experiences in their daily lives (Cansüngü, 2000; Şahin, İpek & Ayas, 2008). In a study (Galili & Hazan, 2000), it was claimed that students had difficulties in learning concepts related to the light due to the way they structured light rays in their minds. In another study (Popov, Zackrisson & Olofsson, 2001) the study

group consisting of university students were asked, what type of path a light beam hitting an aquarium follows. Interesting answers have been obtained and approximately 19% of the students responded as “follows a straight path.”. In the same study, it was emphasized that university students had difficulty in associating even simple geometric optical representations with real situations. In another study (Gemici, Küçüközer & Kocakülah, 2002), it was stated that the correct responses given by the physics teacher candidates about the geometric optics were in smaller percentages than the correct answers of other subjects.

Guesne, Driver, and Tiberghien (1985) stated in a study they conducted with middle school students (13-14 years old) that they generally see light as an entity. Ramadas and Driver (1989), who asked the students to make definitions concept of light, stated that the participants made definitions as “long, thin and shining lines” in the study, and that they had difficulty in expressing the presence of light because the path taken by the light was not directly visible. In the study titled “Investigation of the knowledge levels of pre-service science teachers about the concept of light” with 99 participants, it was seen that the rate of those who had completely correct and complete information and at the same time drew correctly and completely was only 2% (Kara, Erduran Avcı & Çekbaş, 2008). In another study conducted by Kaya (2010), it is stated that interesting findings were obtained by analyzing the answers written by 62 teacher candidates studying in the third year of the science teaching program to the questions asked about the definition and structure of light. In the study, it was revealed that only 32% of the participants wrote correct and acceptable answers to the definition of light and 26 % to the structure of light. In another study (Akdeniz, Yıldız & Yiğit, 2001), the study group consisted of 240 sixth-grade students, it was stated that approximately 70% of the participants had difficulty in understanding and expressing the concepts of light definition, light propagation, the reflection of light and refraction of light. In addition, in the same study, it was claimed that approximately 30 % of the same students had misconceptions about the same concepts.

In the research, it is seen that students generally have difficulties in understanding and learning the concepts related to the light, and they have misconceptions about the subject of light. Based on the aforementioned situation, it is predicted that it is necessary and important to investigate the level of understanding of the basic concepts of light by the primary school teacher candidates.

1.2 Purpose of the Study

This study aims to investigate the level of understanding of light-related concepts of teacher candidates who took the “Basic Science in Primary School” course in the classroom teaching undergraduate program.

2. Method

2.1 Research Design

This research is a descriptive study. Screening studies are generally defined as the presentation of existing, or lived events. Data collection tools consisting of questionnaires, interviews, observations, multiple choice, open-ended and fill in the blanks questions can be used in descriptive studies (Sönmez & Alacapınar, 2018, pp. 47-49).

2.2 Study Group

The study group consists of 65 teacher candidates, 51 female, and 14 male, who are studying in the first year of the classroom teaching undergraduate program at a state university. The "Basic Science in Primary School" course, which aims to provide pre-service teachers with the concepts of science in the primary education undergraduate program, is given in the spring semester of the first year. For this reason, pre-service teachers studying in the first grade in the spring semester were preferred as the study group. The preference of the study group in accordance with the purpose of the research as stated is considered purposive sampling (Büyüköztürk et al., 2013, pp. 90-91).

2.3 Data Collection

In the study, an opinion form consisting of five open-ended questions prepared by the researcher was used as a data collection tool. Content validity was supported by taking the opinions of experts in the field (Büyüköztürk et al., 2013). To make the open-ended questions in the opinion form clear and understandable, necessary corrections were made in line with the feedback received from the experts. The opinion form was applied to the teacher candidates based on the principle of voluntariness. Under the supervision of the researcher, pre-service teachers were provided to write and answer five open-ended questions in a way that would not allow them to interact.

In addition, a semi-structured interview was conducted with six randomly selected teacher candidates about the answers they wrote for 5 questions. No video or audio recording device was used during the interview. In the interviews, participant 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 and the necessary arrangements were made immediately for the missing or incorrectly written statements. Among the opinions of the 6 participants who were interviewed, three opinions that were thought to be interesting were presented under the relevant heading in the findings section.

2.4 Data Analysis

The descriptive analysis method was used to organize the obtained data. In the descriptive analysis method, the data are meaningfully and logically brought together, organized and defined in an understandable way (Yıldırım & Şimşek, 2018). Then, necessary inferences are made and the findings are interpreted. In the study, the answers written by the pre-service teachers for each open-ended question were examined in detail. Considering the similarities of the written answers, they were grouped under certain categories. The categories created were re-examined and grouped expressions with common and similar meanings were reassembled. The grouped answers of the teacher candidates, the number of women, men and total participants, and their percentages were calculated and transferred to the relevant tables prepared separately for each question. After each table, the inferences and comments about the grouped expressions of the participant teacher candidates are included. In the semi-structured interviews, three opinions that were thought to be different and interesting among the six participant opinions determined based on the statements and explanations written and recorded by the researcher himself, were given exactly under the appropriate title in the findings section.

3. Findings

In the study, the level of understanding of the concepts related to the light of the pre-service teachers who took the "Basic Science in Primary School" course was aimed to reveal. This course aims to make students comprehend the basic concepts of science in the undergraduate education program. For this purpose, the data were analyzed and transferred to five tables.

Question 1. While the distance between a point light source and a curtain is x, an opaque object is placed between the two at a distance of x/2 from the light source and the curtain. The shadow of the object is observed, then this object is moved first towards the point light source and then towards the screen and kept constant at x/4 distances from the source and the screen. What can be said about the area of the shadow formed on the screen in both positions respectively?

Table 1. The Answers Written by the Pre-service Teachers for the First Question

Candidates' answers	Male	Female	Total	%
It first increases, then decreases	12	29	41	63.1
It increases in both positions	1	5	6	9.2
It does not change, it remains the same	-	1	1	1.5
In both cases, it decreases	1	3	4	6.2
It firstly decreases, then increases	-	13	13	20.0
Total	14	51	65	100

The pre-service teachers' responses about the area of the shadow of the opaque object on the screen or the screen are seen in Table 1. When the written answers and percentages were examined, 63.1% of the participants wrote the correct answer in the first line, while 36.9% wrote incorrect answers.

Question 2. As seen in a rainbow, when daylight is properly passed through a prism, it usually splits into its constituent colors. Which of the colors listed as green, yellow, red, brown, blue, and orange is not among the colors that make up daylight?

Table 2. The Responses Written by the Pre-service Teachers for the Second Question

Candidates' answers	Male	Female	Total	%
Green	1	-	1	1.5
Brown	12	51	63	96.9
Blue	1	-	1	1.5
Total	14	51	65	100

In Table 2, it is seen that the pre-service teachers wrote 96.9% correct answers for the second question asked about the colors that make up visible light. Asking the question by associating it with the rainbow may have provided the correct answer at a high rate. Because the formation of the rainbow is a common event and observed in nature -particularly in the geography of Türkiye- and attracts the attention of individuals from a young age. Based on the findings, it can be deduced that asking questions in the learning process by associating them with daily life or nature increases the rate of writing correct answers and the achievement.

Question 3. Write an incorrect statement about the refraction of light?

Table 3. The Responses Written by the Pre-service Teachers for the Third Question

Candidates' answers	Male	Female	Total	%
The angle of incidence that makes the angle of refraction 90^0 is defined as the boundary angle	2	9	11	16.9
The light that comes perpendicular to the surface separating the two transparent media passes into the second transparent medium without being refracted.	2	6	8	12.3
Regardless of the angle of incidence, light passes from a highly refractive transparent medium to a less refractive transparent medium	10	36	46	70.8
Total	14	51	65	100

In educational institutions, students are often asked about the correct features of the concepts. It was stated in the interviews that some participants found it interesting to be asked to. Some of the participants found to be asked to write an incorrect statement about the refraction of light interesting. The first two (29.2%) of the three answers written in Table 3 are correct characteristics about refraction. The answer in the third line was written as an incorrect statement by 70.8% of the pre-service teachers participating in the study. When the wrong answer is examined, it can be deduced that it is a statement that can be written by pre-service teachers who have a good understanding of the concepts of boundary angle and full reflection and have correctly structured it in their minds.

Question 4. Which of the objects, substances, and environments listed as air, water, glass, mirror, and lens are opaque?

Table 4. The Answers Written by the Pre-service Teachers for the Fourth Question

Candidates' answers	Male	Female	Total	%
Weather	-	6	6	9.2
Mirror	12	37	49	75.4
Glass	-	3	3	4.6
Water	1	4	5	7.7
Lens	1	1	2	3.1
Total	14	51	65	100

When the answers written for the fourth question are examined, it can be seen that 75.4% of the participants have sufficient knowledge about the concept of opaque. However, it can be said that a substantial proportion (24.6%) of the participants have problems or experience difficulties with opaque objects, opaque substances and environments. If the words “not transparent” were used instead of the word “opaque” in the fourth question, would approximately 25% of the participants write transparent, such as air, glass, water, and lens, as opaque? Nothing definite can be said about this. However, it was suspected that 25% of the participants did not know that the word “opaque” means “non-transparent”. Nor can it be claimed that all participants know that the word “opaque” means “non-transparent”. In teaching settings, when a concept is introduced, examples that best represent that concept are selected. Appropriate examples were selected for the concept of transparency; air, water, glass, and lens. It was thought-provoking and interesting that the participants (24.6%) wrote these samples as “opaque” in the study.

Question 5. Write a misconception about light that you think is common.

Table 5. The Responses Written by the Teacher Candidates for the Fifth Question

Candidates' answers	Male	Female	Total	%
Almost all of the light that comes perpendicular to the surface of transparent objects or environments passes through	-	4	4	6.2
In the reflection of light, the angle of incidence is always equal to the angle of reflection	-	3	3	4.6
Dark surfaces absorb more light	2	5	7	10.8
The light spreads along the lines	1	3	4	6.2
The moon, the satellite of our world, is a source of light	11	36	47	72.3
Total	14	51	65	100

The fact that pre-service teachers are aware of the existing misconceptions about the subjects they want their students to learn in the science lesson when they are appointed as teachers may force them to be more careful about avoiding new misconceptions. When Table 5 is examined, the misconception about light, which is thought to be common and written by 72.3% of the participants, is the statement given as "The moon, the satellite of the Earth, is a source of light". The answers given in the first, second, third and fourth lines of Table 5 and written by 27.7% of the participants are statements that do not have any misconceptions about light and are even scientifically correct.

Opinions Expressed by Pre-service Teachers in The Interview

Three of the opinions expressed by the six interviewees, which were previously stated in writing and thought to be different and interesting from those presented in the tables, are given below.

I thought I wrote the answer to the question about the area of the shadow correctly as "decrease, increase". But then I looked through my notes and other books, researched and understood that the correct answer should have been written as "increase, decrease".

We are often asked to know or write the correct expressions. Therefore, I can say that I have a very difficult time writing an incorrect statement.

I like the question about the misconception. Because I think that teachers should be aware of common misconceptions about every science subject.

4. Conclusion, Discussion, and Recommendations

It has been revealed that the scientific knowledge of the pre-service teachers about the shadow area of the opaque object placed in front of the point light source is not at the desired level. Some participants found it interesting that teacher candidates were asked to write an incorrect statement about the refraction of light. However, it was observed that some of the participants had difficulty in writing the wrong answer. The idea that the participants gave erroneous examples about opaque objects, opaque substances and environments and that the meaning of the word "opaque" might have been caused by these incorrect examples were not known came to the fore. It was found that among the answers given by the pre-service teachers to write a misconception about light, there were scientifically correct statements without misconceptions. In addition, it can be deduced that asking science questions by associating them with events observed in daily life or nature increases the writing of correct answers and thus the achievement. Considering the opinions of the three participants given in the findings section, it is seen that they support the accuracy of the results and relevant comments.

The study, whose participants were pre-service teachers and university students (Kara, Erduran Avcı & Çekbaş, 2008; Gemici et al., 2002; Kaya, 2010; Popov et al., 2001) and the study whose sample consisted of secondary school students (Akdeniz et al., 2001) support the results of this study.

It is considered important to consider the following learning suggestions about the concepts related to the light are considered significant.

1. Using understandable language,

2. Associating the questions that are thought to be asked in discussions or exams with real life or observable natural events,

3. Discussing the incorrect features of light concepts by emphasizing that they are mistaken,

4. Mentioning the common misconceptions in the literature regarding the concept of light.

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