

High School Students' Ideas about Concepts Related to Chemistry and Physics: An Exploration of Common Misconceptions in Science

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Abstract: *The concern for the students' psychological health is an important aspect in order to obtain a qualitative learning system in the education environment. Misconceptions often pose strong barriers to understanding in science. As a consequence of traditional teaching, misconceptions can stick together with the learned scientific theories and are obvious in specific contexts, be it daily or academic. In this study, it is aimed to determine high school students' ideas about concepts related to light before and after instruction. For this purpose, 30 students were asked 8 questions. Students' ideas were grouped under "no answer", "misconception", "exactly answer" and "wrong answer" categories. After instruction most of the responses to these eight questions take part in scientific or scientific fragment categories.*

Keywords – *Misconception, Student idea, Concepts, Instruction*

I. Introduction

At the level of high school and academic environment, teachers should provide a framework that integrates both mental health education and learning curricula. In this way, learning strategies should improve with experiential and interactive teaching strategies to promote health and skills development for the students [1-3].

Concepts can be considered as ideas, objects or events that help us understand the world around us [4]. On the other hand, misconceptions can be described as ideas that provide an incorrect understanding of such ideas, objects or events that are constructed based on a person's experience including such things as preconceived notions, non-scientific beliefs, naïve theories, mixed conceptions or conceptual misunderstandings [5-10]. There are many possible sources for the development of misconceptions. For example, when parents or other family members are confronted with questions from their children, rather than admitting to not knowing the answer, it is common for them to give an incorrect one. Other sources of misconceptions include resource materials, the media and teachers [11]. Therefore, children must meet their own beliefs along with their restrictions and then effort to revive the knowledge necessary to understand the scientific model being presented.

Although native and real misconceptions can mostly be corrected, it is not effectual for a teacher simply to persist that the student disconnect preconceived image and ingrained nonscientific opinions. The research on students' conceptual misunderstandings of natural phenomena demonstrates that new concepts cannot be learned if intermittent models that explain a phenomenon already exist in the student's thought [12-20].

In continuation of our recent studies [21], and due to the importance of understanding the concepts related to light for the first semester students of the university specifically for students of chemistry and physics, the present study aims to investigate the basis of high school students' misconception of the concepts related to light and the strategy to modify it.

II. Results

In recent years in constructivist learning theory that widely accepted in education system, students' ideas before education are quite important. These ideas generally defined as misconceptions in the literature often contradict with scientific ideas. Since misconceptions appear as a learning disability in learning process [22], it is important to determine misconceptions that students have and ensure the exchange of these misconceptions with scientific facts. Also, Students' misconceptions before or after formal instruction have become a major concern among researchers in science education because they influence how students learn new scientific knowledge, play an essential role in subsequent learning and become a hindrance in acquiring the correct body of knowledge.

On the other hand, an understanding of the concept of light is fundamental to subsequent learning of various topics in chemistry and physics, including, molecular structure, color of object, Bohrs' Atomic Model

and so on. The purpose of this study is to begin to identify some of misconceptions held by students in concepts related to light through individual interviews with a group of students.

For this purpose, the test was conducted in normal circumstances and without prior notice to students. A total of 30, 10th grade students from a high school were selected and participated in this study. Questions were built around eight dimensions:

1. Picture and sound on the TV is better at night, why?
2. Despite the sun shining in space, Why is space black?
3. What is the reason for the color change of clothes by getting wet?
4. Why is the sun yellow? Why is the sky blue?
5. Why do stars twinkle at night?
6. The light spectrum consists of seven colors, why do we see the light spectrum without color?
7. Why are some gases colorless and invisible?
8. Why do not gases finish?

By asking students conceptual questions, some students' misconceptions about light were presented and investigated. The interviews were analyzed qualitatively to discover patterns of thought in each individual student. The answer keys to the questions were prepared by applying expert opinions. The responses of 30 students, who were interviewed with interviewers, were compared to the answer key. The answers were classified under the headings of "no answer", "misconception", "exactly answer" and "wrong answer". Description of these categories are as follows (Table 1).

Table 1. Categories of Student Answers

Categories	Explanations about the categories
No Answer	No responses and no explanation
Misconception	Responses that included irrational or incorrect information
Exactly Answer	Responses that can be accepted complete
Wrong Answer	Responses that contained irrelevant information or an unclear response

the frequency of the responses under these four categories is expressed in numbers in table 2.

Table 2. Frequency of student response categories based on interview results

Entry	Questions	No answer	Misconception	Exactly answer	Wrong answer
1	Picture and sound on the TV is better at night, why?	1	7	10	12
2	Despite the sun shining in space, Why is space black?	1	18	10	1
3	What is the reason for the color change of clothes by getting wet?	1	27	1	1
4	Why is the sun yellow? Why is the sky blue?	3	25	0	2
5	Why do stars twinkle at night?	3	23	1	3
6	The light spectrum consists of seven colors, why do we see the light spectrum without color?	1	25	0	4
7	Why are some gases colorless and invisible?	2	28	0	0
8	Why do not gases finish?	3	15	10	2

When we examine the student responses, in the first question seven of the students gave responses falling into misconception category, 12 of them said wrong answers and one students' answer was located in no answer category (Table 2). When we consider the responses to the second question, ten of the students submitted understanding level answers about color of space, while the responses of the remaining (18 of them) fell into misconception category. Next, one student gave response in exactly answer category about changing

color of cloths and most of them were in misconception category (27 students, Table 2). According to the finding of forth question of the interview, 25 of students fell into misconception category for the question about color of sky and sun, and the rest gave no answer and wrong answer. In the fifth question, the main concern was twinkling of stars. Only one student gave understanding level answers to the question and 23 of them gave misconception level answers.

For the question related to light spectrum, 25 students gave misconception level, one student no answer level response and the remaining gave wrong answers. The aim of the 7th interview question was to collect the opinion of the students about the gases. When their responses examined, it was determined two students responded the question in no answer category and the rest of them fell into misconception category. When ten of the students responded the 8th question with responses suitable for understanding category, the remaining of them fell into misconception category, no answer and wrong answer.

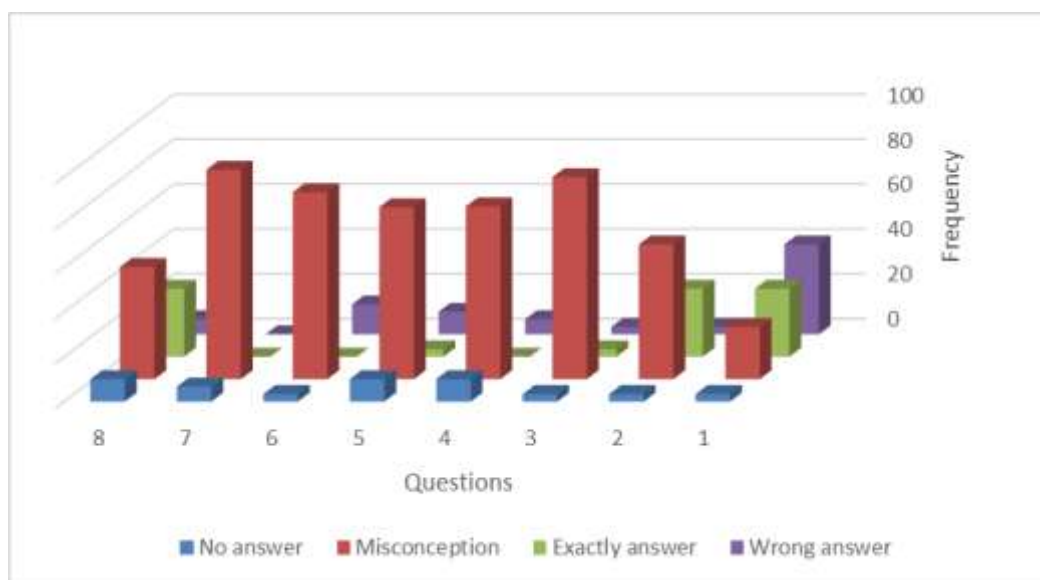


Table 3. The presence of high level of misconceptions in the students' responses

The presence of high level of misconceptions in the students' explanation indicates their fragmented understanding of these abstract concepts (Table 3). This may stem from lack of knowledge of students. Also, the differences between misconceptions of students may stem from their training levels. Misconceptions arise not only from students' contacts with the physical and social world and from textbooks [23], but also as a result of interaction with teachers [24]. Teachers should discuss the abstract concepts in their classrooms in order to eliminate students' misconceptions regarding these concepts. If the misconceptions are remedied at the end of secondary school, students learn scientific concepts more easily. Teachers have the most important tasks because they are those who plan and apply teaching intended for conceptual change. For this reason, the teachers should be aware of the most common misconceptions about the subject and question possible causes about origins of these misconceptions [25]. In this case, teaching by using proper methods (for example, teaching the concepts in accordance with the constructivist theory) modifies students' ideas and would be appropriate.

Hence, in this study, the concepts in accordance with the constructivist approach were taught. Next, it conducts another investigation with the same students after a period of time to check whether the misconceptions removed permanently. As a result of this study, the education which carried out according to the requirements of science programs based on the constructivist teaching theory has a great effect on changing students ideas which were not compatible with scientific ideas. In fact, an increase has been observed in the rate of scientific response about the concept of light after correct instruction. Also, a reduction has been observed in the frequency of encountering misconceptions.

III. Conclusion

Students at each level take several science classes during their schooling in order to learn various science concepts including light. These concepts are basic to scientific concepts and act as an important role in

the understanding of other concepts in different disciplines of natural sciences. The students' misconceptions in learning science concepts are due in part to the teachers' lack of knowledge regarding students' prior understanding. It is revealed 10th grade high school students' pre and post education ideas about light concepts. Although specific misconceptions cannot be identified from the small number of interviews performed, trends in student responses revealed that students have some difficulties in understanding light and hold several misconceptions about it. Instruction accordance with the constructivist approach after interview has given an increase in the scientific response for all the questions.

Further studies concerning the various teaching methods are used for the promoting understanding of science concepts are ongoing.

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