ALTERNATIVE IDEAS ABOUT LIGHT IN ELEMENTARY EDUCATION
PRE-SERVICE TEACHERS

Diego Airado-Rodríguez¹, Alicia Martín², María A. Dávila², M. Dolores Víctor-Ortega³, Florentina Cañada²

¹University of Jaén (SPAIN)
²University of Extremadura (SPAIN)
³University of Granada (SPAIN)

Abstract

This paper aims to address the alternative ideas of pre-service teachers, about the phenomenon of light. The selection of academic contents has been carried out according to the corresponding curriculum of Elementary Education. The considered sample consisted on 76 pre-service teachers, and the employed instrument for alternative ideas’ detection was a questionnaire. Students were asked to fill in the questionnaire in two key moments of the research: before instruction (pre-test) and after instruction (post-test). The active and participative character are the main features of the implemented instruction.

The found alternative ideas were related e.g. to the dual feature of light; to the prediction and explication of the color of the objects; to the understanding of the phenomena of reflection, refraction and dispersion of light; or to the prediction of the behaviour of light in optical instruments kind of mirrors of lenses.

The obtained results showed that there was a significative increase in the number of right answers selected in the questionnaire after the instruction was carried out. However, there was a percentage of some alternative ideas that prevailed after instruction, which demonstrated their resistance to change.

Keywords: alternative ideas, light, conceptual change, university students, theoretical-practical intervention.

1 INTRODUCTION

It is known that students build new knowledge on the base of the alternative ideas they have about any topic. Alternative ideas are mental elementary constructions that helps students to understand everyday phenomena. Thus, the finding of alternative ideas by the instructor is a must to achieve a significant learning [1].

In past decades, education professionals did not give importance to the previous ideas that students could possess. Nowadays, this trend has hopefully changed, since the new teaching-learning models take into account that students possess a wide range of ideas that have built themselves over the years, with respect to the concepts given in the classroom, fruit of their experience. The importance of detecting the alternative ideas of the students for both the scientific evaluation and the teaching-learning process is well described in the related literature [2, 3].

It should be noted that within the different contents that form science subjects, the Physics’ contents are those that generate the most negative emotions among students [4]. The acquisition of the capacity for conceptualization and mathematical skill that Physics requires, might be the main obstacles for their intellection.

In this scenario, the main objective of the project to which this work belongs consists on exploring the alternative ideas regarding the concept of light in pre-service teachers light. The investigation arises in the first instance, due to the presence of alternative ideas that make difficult the significant learning of of sciences. And secondly, in an aim to improve the process of conceptual change through theoretical-practical interventions.
2 METHODOLOGY

The considered sample consisted of 76 pre-service teachers, receiving the last year of the grade of teacher in Primary Education. The process of selecting the sample has been performed by convenience, due to accessibility criteria.

A self-created questionnaire has been used as instrument for data collection. This questionnaire picks up a series of socio-demographic variables of the participants, namely: age, sex, high school specialization, university access mark, grade average mark, their favourite subject and their least preferred subject in high school. The questionnaire consists on seventeen questions as follows:

- Thirteen questions are test type with different options but with only one correct option.
- An affirmation to define as “true or false”, composed of statements related to light and its projection.
- A graphic representation composed of the sun, a tree and a girl, where the direction of the light must be indicated so that the girl in the image can observe the object, in this case a tree.
- A mixed question with a closed answer part and a second part where the election must be justified.
- Finally, the questionnaire is designed with a last open-answer question, where students must respond with their words what light is.

The questionnaire was elaborated bearing in mind the “Decreto 103/14, de 10 de junio”, which establishes curriculum of Elementary Education in “Comunidad Autónoma de Extremadura” and “ORDEN ECI/3857/2007, de 27 de diciembre”, which establishes the requirements for verification of University-titles that qualify students for the exercise of the profession of teacher of Elementary Education.

The research has been carried out in three phases:

1. the first one has consisted in the detection of misconceptions using a questionnaire as instrument (pre-test);
2. secondly, an intervention with theoretical-practical nature has been carried out, with a great load of manipulative tasks;
3. and finally, the evolution of misconceptions has been judged, using the same questionnaire as in the first phase (post-test).

The active and participative character is the main feature of the implemented instruction.

The analysis of the answers to the open-answer questions of the questionnaire was carried out by categorizing the answers and calculating frequencies and percentages. The statistical analysis of the results has been carried out using the chi square test ($\chi^2$).

3 RESULTS

Regarding the socio-demographic features of the sample, 82% women formed the sample and the majority of the sample was in the age interval 20-22 years-old. Regarding their high-school specialization, most of the students integrating the sample came from the Social Sciences (49 %) and Humanities (26 %) itineraries and only 15 % of the sample came from Technology or Health Sciences itineraries. The average mark of University access was 7.02 and the average grade mark was 6.79. Regarding their favourite subject in the high school, it was found a vast variety of answers as it can be observed in Figure 1, but it is noteworthy that only 3% of the sample answer Physics, which is the subject in which the teaching of the light phenomena takes place. Finally, regarding their least preferred subject in the high school, as it can be observed in Figure 2, 37 % of the sample selected mathematics, followed by 14 %, which selected Physic and Chemistry.
As an example, the analysis carried out on the answers provided by the students to some of the questions in the questionnaire is shown below.

**Question number 1:**
A white wall looks white because:
   a) It has and emits white light.
   b) White light arrives to the wall and the wall reflects it.
   c) It absorbs all the light that arrives to the wall.

The right answer is answer “b”. The obtained results in the pre-test and post-test are summarized in Table 1, as percentage of students choosing each answer in each case. As it can be observed, in the pre-test more than one half of the students selected option “c”, while option “b” was selected only by 39.1 % of the sample. In the post-test the option “b” is the one receiving the highest percentage of election, namely 61.5 % of the sample.
Table 1. Percentage of students answering “a”, “b” or “c” to question number 1, in the pre-test and post-test.

<table>
<thead>
<tr>
<th></th>
<th>PRE-TEST</th>
<th>POST-TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) It has and emits white light.</td>
<td>6.5 %</td>
<td>10.7 %</td>
</tr>
<tr>
<td>b) White light arrives to the wall and the wall reflects it.</td>
<td>39.1 %</td>
<td>61.5 %</td>
</tr>
<tr>
<td>c) It absorbs all the light that arrives to the wall.</td>
<td>54.3 %</td>
<td>27.6 %</td>
</tr>
</tbody>
</table>

As described above and as it can be observed in Table 1, there is an increase in the percentage of students selecting the right answer after the intervention and the application of the statistical test $\chi^2$ reveals that this is a significant increase ($p <0.05$).

**Question number 2:**
Suppose that a white object is illuminated with yellow light, what colour will it show?
- a) White.
- b) Yellow.
- c) Black.
- d) The object will not be seen.

The right answer is answer “b”. The obtained results in the pre-test and post-test are summarized in Table 2, as percentage of students choosing each answer in each case.

Table 2. Percentage of students answering “a”, “b”, “c” or “d” to question number 2, in the pre-test and post-test.

<table>
<thead>
<tr>
<th></th>
<th>PRE-TEST</th>
<th>POST-TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) White.</td>
<td>19.5 %</td>
<td>11.2 %</td>
</tr>
<tr>
<td>b) Yellow.</td>
<td>76.0 %</td>
<td>83.8 %</td>
</tr>
<tr>
<td>c) Black.</td>
<td>0.0 %</td>
<td>1.6 %</td>
</tr>
<tr>
<td>c) The object will not be seen.</td>
<td>4.3 %</td>
<td>3.2 %</td>
</tr>
</tbody>
</table>

As it can be observed in Table 2, most of the students selected the right answer both in the pre-test and in the post-test, but the percentage increases from 76.0 % to 83.8 % as a consequence of the performed intervention. The application of the statistical test $\chi^2$ reveals that in this case the increase is not significant ($p >0.05$).

**Question number 3:**
The phenomenon that explains the formation of the rainbow is:
- a) Refraction.
- b) Reflection.
- c) Polarization.
- d) Dispersion.

In this case, the right answer is answer “d”. The obtained results in the pre-test and post-test are summarized in Table 3, as percentage of students choosing each answer in each case.
Table 3. Percentage of students answering “a”, “b”, “c” or “d” to question number 3, in the pre-test and post-test.

<table>
<thead>
<tr>
<th></th>
<th>PRE-TEST</th>
<th>POST-TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Refraction.</td>
<td>63.6 %</td>
<td>19.0 %</td>
</tr>
<tr>
<td>b) Reflection.</td>
<td>11.3 %</td>
<td>9.5 %</td>
</tr>
<tr>
<td>c) Polarization.</td>
<td>18.1 %</td>
<td>0.0 %</td>
</tr>
<tr>
<td>c) Dispersion.</td>
<td>6.8 %</td>
<td>71.4 %</td>
</tr>
</tbody>
</table>

In this question, the answer with the highest percentage of selection in the pre-test was answer “a”, while the right answer was selected only by 6.8 % of the students. In the post-test it was observed a drastic change and the right answer was selected by 71.4 % of the sample, as a consequence of the performed intervention. The application of the statistical test $\chi^2$ reveals that in this case the increase from 6.8 % to 71.4 % is statistically significant ($p <0.05$).

4 CONCLUSIONS

The obtained results showed that in general there was a significant increase in the number of right answers selected in the questionnaire as a consequence of the performed instructions. However, there was a percentage of some alternative ideas that prevailed after instruction, which demonstrated their resistance to change.

ACKNOWLEDGEMENTS

This work has been funded by the research project EDU2016-77007-R (AEI / FEDER, UE) and the “Ayuda a Grupos de investigación” GRU18004 of the Junta de Extremadura and FEDER.

REFERENCES


