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RECENT DEVELOPMENTS CONCERNING DIFFERENTIATED TREATMENT OF STUDENTS WHILE STUDYING THE CHAPTER "LIGHT AND SOUND"

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Abstract: The present work develops a research study carried out by the author between 2000-2002, concerning the differentiated treatment of students while studying the chapter "Light and Sound". During the 2012-2013 school year, as far as optical and acoustic phenomena are concerned, there were carried out representative and functional experiments which would highlight light reflection, light refraction, light dispersion or sound propagation by using recyclable materials. The learning tasks designed for students included performance problems distributed per level groups. This approach greatly contributed to stimulating students' motivation for learning, their reasoning and critical thinking. The good and very good results obtained by the students in the experimental classes, as compared to those in the control class, encourage us to trust the efficiency of learning within training, in which differentiated learning represents the main strategic option.

Key words: Physics didactic, differentiated treatment, pedagogical experiment.

1. Introduction

In the National Education Law (2011, Art.2, paragraph 3) it has been stipulated that the educational ideal of the Romanian school consists of the free, complete and harmonious development of human individuality, of shaping autonomous personality and of assuming a system of values which are necessary for personal fulfilment and development, for the development of entrepreneurial spirit, for active, civil participation within society, for social inclusion and for employment on the labour market. We consider that for achieving this ideal, a major role is represented by the approach of the didactic process from the perspective of differentiated treatment, as teacher's strategic option.

Students are not identical and the aspects which differentiate them are numerous. We all are conscious of this fact: students, parents and teachers. As a result, Gregor & Chapman (2007, p.2) consider that differentiation is some sort of philosophy which motivates teachers to plan learning activities meant to equally satisfy students' needs and interests and also curricular standards. Referring to the particular case of learning for sciences, D' Amico & Gallaway (2010, p. XIII) mention:

> "Students need time to think about scientific concepts in inquiry-based laboratory experiments and time to share their ideas with a partner or in groups. The goal is to move the student's thinking from a knowledge base of information to the application level, and beyond to the "What if . . . ?" questions and synthesis level of Bloom's Taxonomy of the Cognitive Domain."

Differentiation targets mainly: the content of learning, the performances aimed at, training strategies, the process of learning respectively, the support offered by the teacher to his students and the assessment strategies (Gregor & Chapman; 2007, p.3; Nordlund, 2003, p.3, Pop & Ciascai, 2010).

2. Research carried out during the 2012-2013 school year

The research carried out in the present study took place during the 2012 – 2013 school year. It

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represents a sequel to a previous research concerning differentiated treatment of students, carried out during 2000-2002 (Florian, 2003).

The subjects involved into the 2012-2013 research are all students at the National College "Carol 1st" in Craiova. As far as sampling is concerned, the work was carried out with independent samples, that is, whole student classes, the exact way they had been formed within the school. The control class was 7th B (CC) and the experimental classes were 7th C (CE1) and 7th D (CE2). As far as the initial test is concerned, there were no significant differences between the classes.

The research objectives were:

- Developing a methodological system based on students' differentiated treatment in the process of teaching and learning Physics, elaborated in the previous research study (2000-2002).
- Experimenting the new learning frame which develops the methodological system founded through the 2000-2002 research.
- Diminishing and eliminating possible dysfunctions, imprecisions and errors in reaching the expected results.

The research implemented in the 2012-2013 school year has preserved the hypothesis of the previous research, namely: "The use of didactic strategies based on students' differentiated treatment, as strategic option, can assure the significant increase of the efficiency of learning for Physics".

In order to test this hypothesis with experimental classes, we have introduced students' differentiated treatment as experimental variable. The content sample respected the specific competences and the scientific contents suggested in the valid Physics curriculum (M.E.C.I, 2009).

Testing the research hypothesis suupposed organizing and developing an experimental inquiry, consisting of a system of didactic experiments, organized for learning-teaching Physics within the chapter "Light and Sound" which is studied in the 7th grade.

In Table 1, there has been achieved a general presentation of the experiment carried out with 7th grade students, chapter "Light and Sound", during the 2012-2013 school year, the area of the research made and the number of students involved into the experiment.

Table 1. *Presentation of content samples and of students, during the 2011-2012 school year, 7th grade, chapter "Light and Sound"*

Didactic activities carried out with experimental classes	**No. of hours**	**Number of students**		**No. of classes**	**No. of students**
		experimental	**control**		
• 6 communication and acquiring new knowledge lessons; • 1 systematization and consolidation lesson; • 1 checking and assessment lesson.	8	CE1: 27 CE2:21	CC: 22	3	70

The methods for research used by the 2000-2002 research included mathematic and graphic modelling, heuristic conversation, problem posing and experiment.

Within the 2012-2013 research, the didactic activities and the tasks for experimental classes included simple experiments, carried out by students with the help of some recyclable materials. The exercises and problems for reaching performance, used throughout the formative intervention, were differentiated by taking into consideration the level groups. For problem solving, the analytical and synthetic method was used systematically. The study and working materials were chosen so that they would incite students (in order to maintain their motivation for the activity).

The characteristic features of the system of lessons administered to experimental 7th grades within the study of the chapter "Light and Sound" have been presented in Table 2.

The project for learning activities has been structured as it follows:

- Analysing the curriculum for identifying the performance standards included in the curricula.
- Diagnosing the starting situation: what do students know?, what are their skills?, what do they want to know? etc.
- Defining the learning objectives: knowledge, skills, attitudes and values, the first ones described in relation with the Bloom taxonomy in the cognitive field.
- Describing differentiated learning activity/activities (tasks, methods and forms of organizing students, contents suggested for study, assessment tests etc.).
- Assessment of the process and learning results.

Students' involvement, individually and in groups, into solving the learning tasks has proved intrinsic motivation for learning Physics.

Table 2. *Characterisation of the system of lessons achieved for the experimental 7th grade while studying the chapter "Light and Sound"*

No.	Title of lesson	No. of hours	Main objective	Operational objectives	The dominant type of learning situation	The system of didactic methods which contribute to learning by differentiated training
1	Light and Sound	1	Identifying procedures of producing light and sounds.	To describe procedures of producing light; To describe procedures of producing sounds;	Lesson of independent differentiated activity	heuristic conversation, explanation, individual, independent and differentiated activity, didactic game
2	Light Refraction. Total Reflection	1	Characterising light reflection and total reflection.	To describe the phenomenon of light refraction; To establish qualitative relationship between the angle of incidence and the angle of refraction;	Lesson based on lab experiments	problem posing, heuristic conversation, graphic and mathematic modelling, individual, independent and differentiated activity, lab experiment
3	Light Dispersion	1	Characterising light dispersion.	To describe the phenomenon of light dispersion;	Lesson of independent differentiated activity	heuristic conversation, explanation, graphic modelling, individual, independent and differentiated activity, lab experiment

No.	Title of lesson	No. of hours	Main objective	Operational objectives	The dominant type of learning situation	The system of didactic methods which contribute to learning by differentiated training
4	Lens. Image Constructions in Lenses	1	Identifying and characterising images by convergent and divergent lenses.	To compare convergent lenses with divergent lenses; To distinguish between real images and virtual images;	Lesson of independent work with worksheets.	problem posing, heuristic conversation, explanation, graphic and mathematic modelling, individual, independent and differentiated activity, experiment, exercise and problem solving
5	The Eye. Glasses	1	Identifying and characterising eyesight deficiency.	To compare eyesight problems and the ways to correct them; To identify the types of lenses used to correct eyesight problems;	Lesson based on applicable exercises and problems.	problem solving, explanation, graphic modelling, individual, independent and differentiated activity, exercises and problem solving, didactic game
6	Sound Sources. Sound Perception and Propagation of Sounds	1	Identifying sound sources, propagation and perception of sounds.	To describe procedures for sound perception; To compare sound propagation in different mediums;	Lesson based on computer assisted self-training.	heuristic conversation, explanation, didactic game, individual, independent and differentiated activity, exercises and problem solving, computer assisted training
7	Revision and Systematizati-on	2	Interpreting optical and acoustic phenomena studied by correlating information acquired through studying the topic with those from the previous cognitive repertory.	To solve specific problems by using the notional content acquired by studying the topic „Light and Sound”.	Lesson of checking/self-checking with the help of worksheets; Synthesis lesson.	graphic and mathematic modelling, individual, independent and differentiated activity, exercises and problem solving

Assessment

During the last three weeks of the 2012-2013 school year, a period of time when the contents in the curriculum studied by the students throughout the school year, are revised and systematized, there were administered assessment tests. These ones were centred upon specific competences and contents associated to the valid Physics curriculum.

The test administered both to the control class (CC) and to the experimental classes (CE1 and CE2), for the chapter "Light and Sound" included two subjects for which stirring tasks were formulated. For subject I, four photos were used, achieved by the author of this study, which highlight optical phenomena. Subject II consisted of a problem testing performance, proposed by Florian, Măceşanu, Moraru & Necuţă (2013). The time allocated for solving the test was of 40 minutes and the maximum score allocated to this test was of 100 points, out of which 10 points were given for granted.

Subject I. Optical phenomena and photos (45 points)

In Figure 1, we can notice some optical phenomena presented with the help of some photos.

- **a.** Explain the formation of the multiple images of the lighter flame in the mirror, for the photo in Figure 1(a).
- **b.** Identify the type of lenses noted by **A** and **B** in the photo in Figure 1(b), giving arguments for your answer.
- **c.** Specify why the spectrum of the white light appears in zone O in Figure 1(c), justifying your answer.
- **d.** Explain why the colour of the shadows of trees on the snow is blue, for the photo in Figure 1(d).

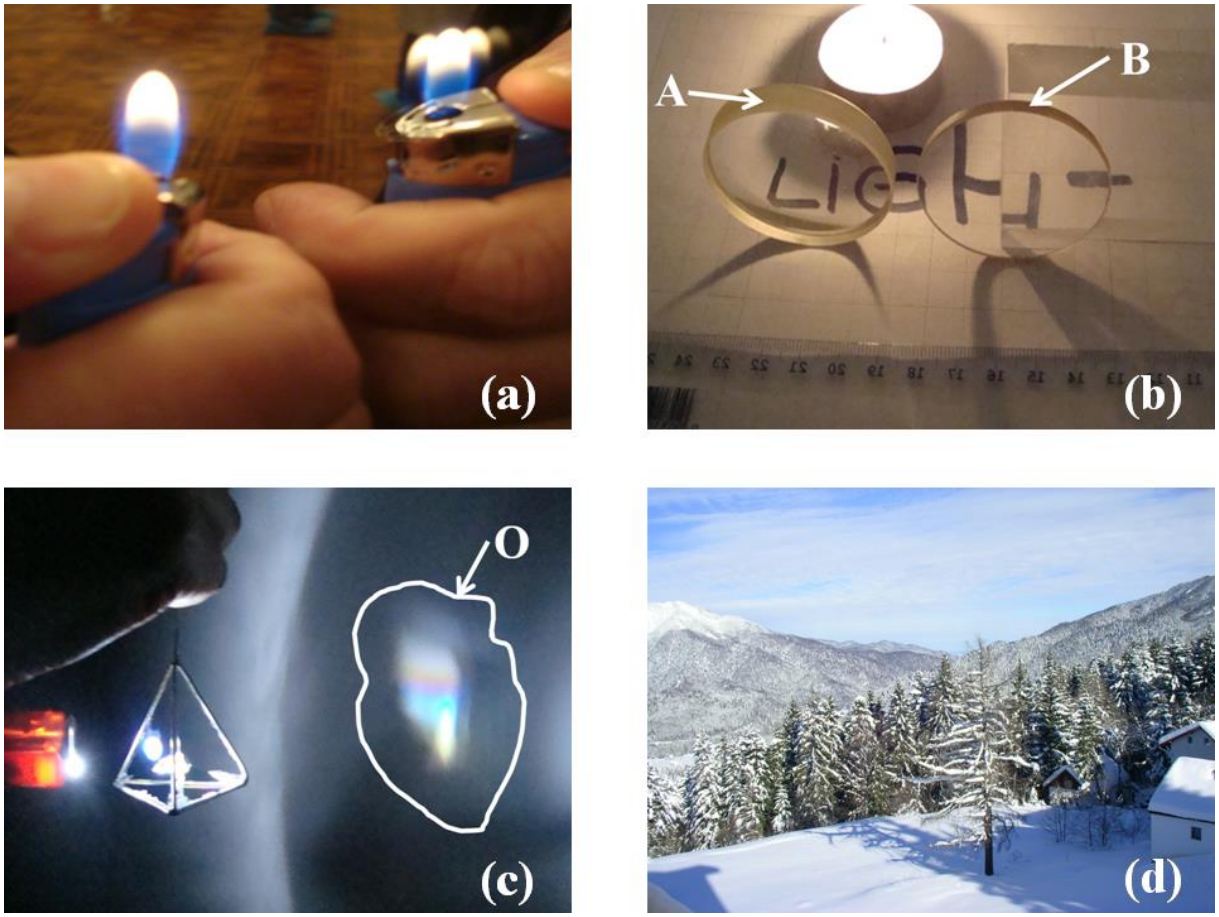

Figure 1. *Optical phenomena presented with the help of a photo*

Subject II. ***The Troublesome Lantern!*** (45 points)

Dani makes an experiment by using a lantern and a parallelepipedic cardboard box of length $L = 80\,\text{cm}$, with the walls **A** and **B** having the side $\frac{L}{2}$ (see Figure 2).

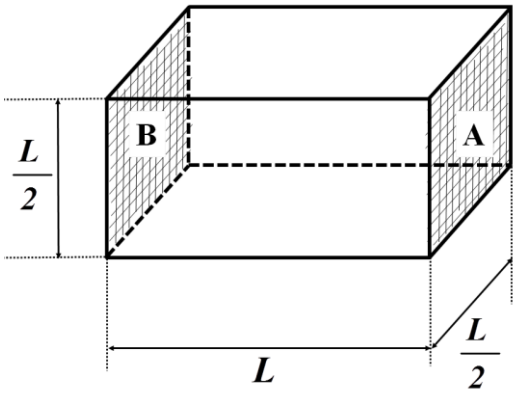

Figure 2. *Modelling in space the parallelepipedic cardboard box, taking into consideration the initial conditions of the problem*

The box is divided into two equal parts by a very thin opaque wall, foarte subțire, provided with a circular slit of diameter $\frac{L}{8}$ in the centre. Let's consider the light bulb of the lantern as being a point-shaped source situated on the central axis of the box at the distance $\frac{L}{4}$ from wall **B**, and the light is emitted only to the right (see Figure 3).

a. Calculate the diameter of the bright disk, which appears on wall **A** of the box.

b. In the place of the circular slit, Dani introduces a thin lens ang obtains the image of the light source on wall **A**. Trace the light beams necessary to forming the image of the source. Calculate the lens convergence.

c. In the absence of the lens from point (**b**), let's suppose that wall **A** is getting silver-plated, turning into a plane mirror. Trace the light beams necessary to forming the image of the source. Calculate the distance between the source and the image.

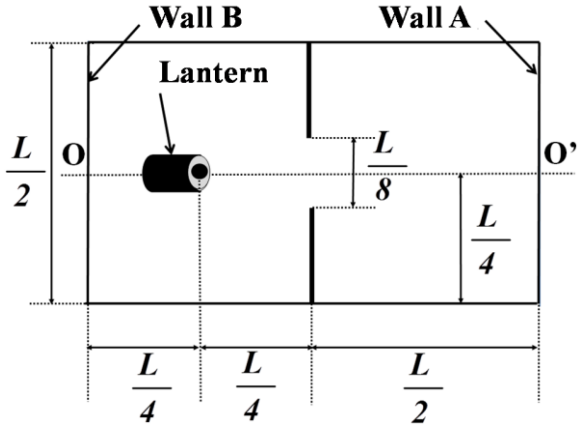

Figura 3. *Modelling in section for the parallelepipedic cardboard box, taking into consideration the initial conditions of the problem*

Results

The results obtained by the students of the control class (CC) and by the students of the experimental classes (CE1 and CE2), for the chapter "Light and Sound" at the previously mentioned test have been presented in brief in Table 3 and Figure 4.

Table 3. *Categories of score, absolute and relative frequencies of the score obtained by the students of the experimental classes and the students of the control class, at the test administered during the final assessment period, 7th grade, chapter "Light and Sound", 2012-2013 school year*

Score Categories	Absolute Frequencies of Score			Relative Frequencies of Score (%)		
	CE1	CE2	CC	CE1	CE2	CC
10-19,99	0	0	0	0,00	0,00	0,00
20-29,99	0	0	0	0,00	0,00	0,00
30-39,99	0	0	1	0,00	0,00	4,55
40-49,99	1	0	3	3,70	0,00	13,64
50-59,99	2	1	4	7,41	4,76	18,18
60-69,99	7	4	8	25,93	19,05	36,36
70-79,99	8	6	3	29,63	28,57	13,64
80-89,99	6	5	2	22,22	23,81	9,09
90-99,99	2	3	1	7,41	14,29	4,55
100	1	2	0	3,70	9,52	0,00

We may notice that the relative frequencies of the score higher than 70,00 are 62,96% for CE1, 76,19% for CE2 and 27,27% for CC.

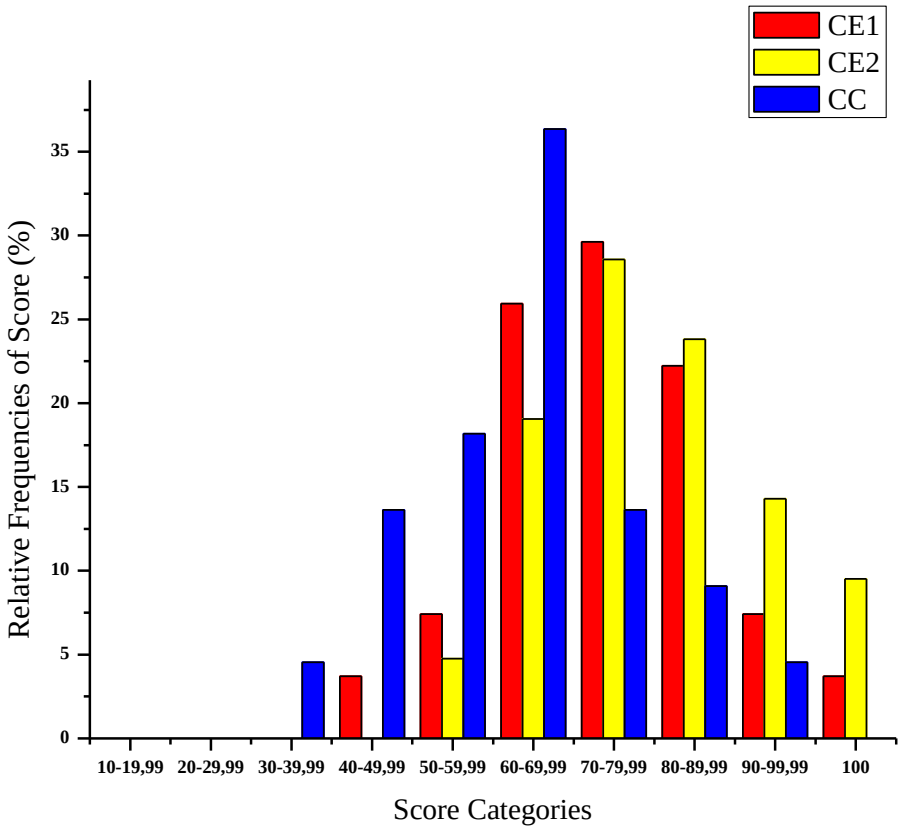

Figure 4. *Distribution of relative frequencies of the score(%) obtained by the students of the experimental classes and of the control class, at the test administered during the final assessment period, 7th grade, chapter "Light and Sound", 2012-2013 school year*

From the data analysis, we may notice that the students of the experimental classes were receptive to the didactic methodologies applied, their competences corresponding to the requirements of the curriculum. In the case of these students, the diminishing or even the complete cancellation of under mediocrity percentages was possible. This fact was due, to a great extent, to the students' systematic training, in a succession of training activities which aroused curiosity, critical reflection and contributed to the formation of new abilities and skills, as well as to the development of the spirit of observation.

The good and very good results of the students of the experimental classes encourage us to trust the efficiency of the learning frame implemented into practice. We must notice that the students who obtained a score higher than 70,00 solved completely and correctly subject I, which included the use of stirring illustrative materials and of simple experiments proposed for testing.

We assign the students' success in identifying optical phenomena in the pictures presented and the good understanding of these phenomena to the systematic use of the experimental method.

There are few situations in which students obtained a score less than 50,00 namely, a student from CE1 and four students from CC. The five students met difficulties not only with subject I, where they had to explain and identify optical phenomena presented by using some photos, but also with subject II, where they had to trace correctly the light beams necessary to:

- identifying the bright disk that appears on wall **A** of the box (for point II.a.);
- forming the image of the source if in the place of the circular slit is introduced a thin lens and the image of the light source is obtained on wall **A** (for point II.b.);
- forming the image of the source in the absence of the lens from point (II.b.), if wall **A** is silver-plated, turning into a plane mirror (for point II.c.);

Observation, discussions with students and analysis of their results show that the source of difficulties met by students in the control class when they were tested, is given by the fact that they were not put systematically into the position of using methods and abilities acquired spontaneously. Without practising systematically critical reflection, experiment, they did not succeed in identifying their deficiencies in observing, understanding and explaining optical and acoustic phenomena.

3. Conclusion

The results obtained suggest that the learning situations based on differentiated treatment of students contribute significantly to the increase of learning efficiency, a fact also confirmed by the quoted literature (Florian, 2003; Ciascai, Florian & Florian, 2008).

Differentiated treatment of students is considered as being multimethodology by Orlich et al. (2010, p.53-54). The research frame implemented into experimental classes was also quite varied. It developed the methodological system used in the previous research, research which included problem posing, problem solving, heuristic conversation, documentation from different sources, active reading, new technologies. With the 2012-2013 research, there have been introduced systematically the experiment and the lab works, as they provide students with numerous possibilities of exploring, observing and interpreting the physical phenomena studied and of being motivated. Practical activities which involve artistic manufacturing of certain didactic materials from recyclable ones were also frequently used. The problems proposed for being solved by students were structured according to levels of difficulty and valued the analytical and synthetic method. In all these situations, the teacher offered his support in a differentiated manner.

The good and very good results confirm the fact the 7th grade students have acquired new knowledge seriously, they have got new abilities by the contents studied in the chapter "Light and Sound".

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