

NEW TRENDS: PROMOTION OF DIDACTIC METHODS THAT FAVOUR THE INCREASE OF STUDENTS' INTEREST AND MOTIVATION FOR STUDYING PHYSICS

LUMINITA DINESCU, CRISTINA MIRON, E.S. BARNA

University of Bucharest, Faculty of Physics, RO-077125 Bucharest - Magurele, Romania,
E-mail: dinesculuminita@yahoo.com

Received June 2, 2010

Abstract. Studies carried out in Europe - Report by High Level Group on Science Education “Science Education Now: A renewed Pedagogy for the Future of Europe”, Report by the High Level Group on increasing Human Resources for Science and Technology in Europe “Europe needs more scientists”, show an alarming decline of the interest in and motivation for the study of sciences in general, of Physics in particular. Unfortunately, this descending trend is also confirmed in Romania. These studies indicate as a possible cause, besides social and economical factors, an old-fashioned approach of the teaching-learning process, for example “chalk and talk” method. Therefore it is recommended the use of some didactic methods adapted to each student’s knowledge level, style and rhythm. In this paper we present a pedagogical experiment conducted in Bucharest, in which 150 high-school students from 6th and 9th grade were involved. The results of this experiment confirm the hypothesis of the research: differentiated instruction according to the student’s readiness and learning profile can lead to a significant increase of the efficiency in learning Physics and implicitly to an increase of the interest in and motivation for the study of this subject.

Keywords: interest, motivation, differentiated instruction, efficiency in learning Physics.

1. INTRODUCTION

Many studies have recently highlighted an alarming decline in young people’s interest for key Science studies and Mathematics [1].

Also, for several years now there have been warnings from universities that the number of students has been declining sharply in certain disciplines, namely Physics, Chemistry and Mathematics [2].

Unfortunately, things are the same in Romania too, meaning that less and less high school graduates are choosing a career in science.

Thus, in Romania the total tertiary graduates in science and technology per 1000 of population aged 20 to 29 years has evolved as following: 5,9 (1997), 4,2(1998), 4,1(1999), 4,5(2000), 4,9(2001) [2]. This tendency was reconfirmed in

2007 by Report by High Level Group on Science Education “Science Education Now: A renewed Pedagogy for the Future of Europe”.

School education has to solve the problem of creating interest and a basic level of expertise for doing science as a career, on the one hand, and of stimulating interest and open-mindedness for dealing with science-based questions and decisions in daily life and in society, on the other hand [2].

The report recently issued by the OECD “Evolution of Student Interest in Science and Technology Studies” identifies the crucial role of positive contacts with science at an early stage in the subsequent formation of attitudes towards science [1].

The studies show that one of the factors that influence the increase of interest, of motivation and of a positive attitude towards the study of sciences generally, and of Physics particularly, is represented by the didactic methods used within the teaching-learning process. More than that, the attention must be focused on the teaching way during primary and secondary school.

Secondary school is the most important level in determining whether students prefer Science studies, since it is at this stage that they can start choosing which subjects they wish to study [3].

In modern didactics, a learning method is understood as a certain way of acting, which tends to place the student in a more or less conducted learning situation that comes close, almost to identification, to one of a scientifically research, of following and discovering the truth and connecting it to practical aspects from life [4].

Old wisdom says that a variety of teaching and learning methods is important for a successful learning process [2].

Listening to the teacher and copying what is on the blackboard, the so-called “chalk and talk” approach is unlikely to achieve this. Priority should be given to deep understanding and methods over raw facts and knowledge [3].

Several recent studies have identified students’ perception of science as a difficult subject as being a determinant of subject choice [5].

Yet, many researchers state that students’ worse results at certain subjects are caused not necessarily by the difficulty generated by the internal structure of knowledge, but mostly by difficulty in adapting to one or another of the methods the teacher uses [6].

A method is not good or bad in itself, but through relating it to the respective didactic situation, the criterion of opportunity or of suitability to a specific reality being what it could make it more or less efficient [7].

It can be noticed therefore the tendency of modern didactics towards a methodology centered on student. This, unlike the equalizing, homogenizing methodologies, promotes some methods that are particular for each person, according to his/her own needs and own learning rhythm [8].

1.1. DIFFERENTIATED INSTRUCTION

Differentiated instruction is a broad term that refers to a variety of classroom practices that allow for differences in students' learning styles, interest, prior knowledge, socialization needs and comfort zones [9].

Even though students may learn in many ways, the essential skills and content they learn can remain steady. That means students can take different roads to the same destination [10].

Teachers can differentiate classroom elements based on student readiness, interest, or learning profile: content, process and products [11, 12], as it is shown in Fig. 1.

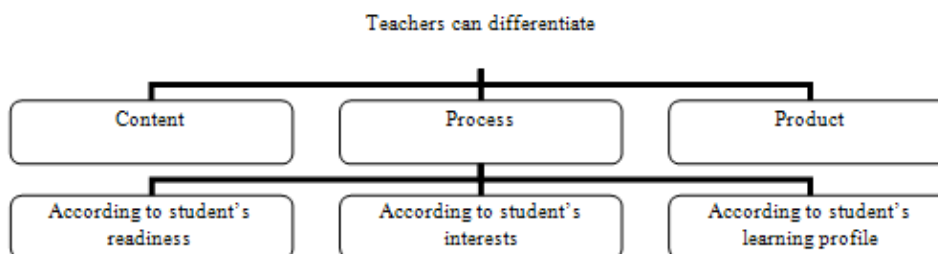


Fig. 1 – Differentiated instruction.

Content is what we use to teach the standards, process is how we teach the standards and products refer to the way students' show us what they know [13].

In this paper, we have studied the benefits that differentiated instruction might have while teaching Physics, accordingly to the student's readiness and learning profile.

Depending on the personalities and interest of the students, the mix of readiness levels we can choose one of three differentiation process: whole class, small group, or individual student differentiation [14].

We have chosen to focus on the whole class differentiation.

Whole class differentiation is about looking at the entire class and differentiating instruction by putting students into groups or by employing other methods that allow all students in the class to work at their individual levels of readiness, learning styles, or interest [14]. Thus, during the classes students are divided into three groups of level: low, middle and high readiness levels.

Examples of differentiating process or activities at the elementary level include the following: using tiered activities through which all learners work with the same important understanding and skills, but proceed with different levels of support, challenge, or complexity; providing interest centers that encourage students to explore subsets of the class topic of particular interest to them; offering manipulative or other hands-on supports for students who need them; and varying the length of time a student may take to accomplish a task in order to provide

additional support for a struggling learner or to encourage an advanced learner to pursue a topic in greater depth [11].

Most important, even though the level of difficulty will be different for each tier, each student should be challenged to do his/her best at whatever level he/she is performing [14].

In organizing the activities within the teaching-learning process we have taken into consideration besides the students' level, also their learning styles preferences.

In order to determine a student's learning styles preferences we have used Visual Auditory Kinesthetic Model.

According to this theory there are: Visual learners – learn by viewing; auditory learners – learn by hearing and speaking; kinesthetic learners – learn through hands on and movement.

Our study was directed towards the visual methods appropriate for the visual learners. Among these, we have discussed concept maps and Venn Diagram, since graphic organizers are an excellent means to help visual/spatial learners organize their thinking [14].

1.2. GRAPHIC ORGANIZERS

Concept maps graphically illustrate relationships between information. In a concept map, each word or phrase is connected to another and linked back to the original idea, word or phrase, as it is shown in Fig. 2. Concept maps are a way to develop logical thinking and study skills, by revealing connections and helping students see how individual ideas form a larger whole.

According to Ausubel's theory, a student's cognitive structure is organized hierarchically and facilitates the assimilation and retention of new knowledge [15]. Unlike the traditional learning methods, concept maps are unique, due to the visual and hierarchical organization of significant interconnections between concepts [16].

Furthermore, Butcher [17] noticed that the visual representations seem to be the most efficient when these are conceived to support the specific cognitive processes necessary for a deep understanding, namely when there is a correspondence between the type of representation and the type of knowledge.

A larger and larger number of studies are pointing out the use of concept maps in identifying the rapport between the teacher's presenting of the respective subject and the students' understanding. More than that, concept maps can be also used to promote learning Physics through cooperation and differentiated treatment. Thus, students can work in small groups and discuss about the understanding of the respective knowledge, and afterwards they can collaborate in order to create a concept map. This approach get students involved in discussions related to the concepts and encourages them to express their opinions about the used concepts and about the interconnections between them [18].

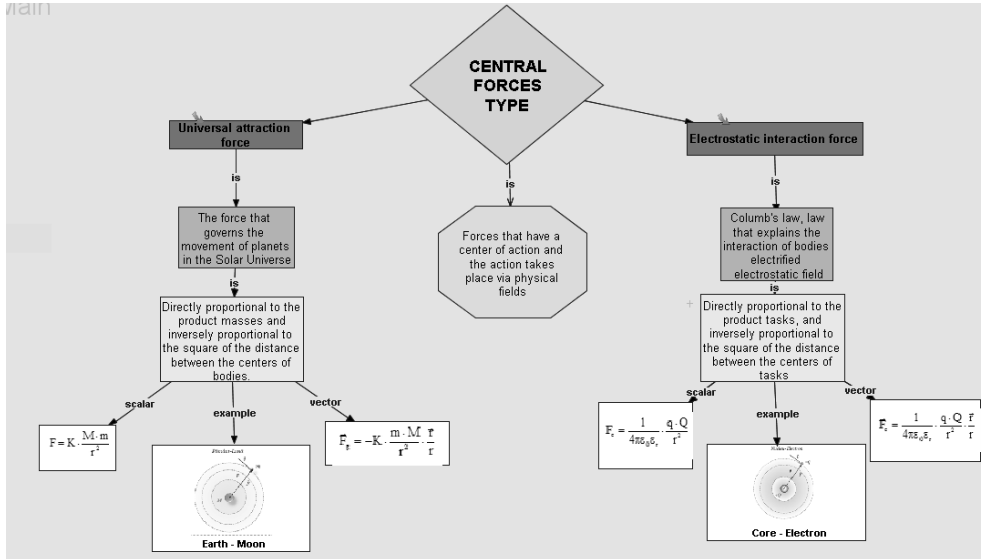


Fig. 2 – Concept map “Central Forces Type”.

Other studies regarding the use and build of concept maps have also shown that the visualizations of the graphic organizers can support learning and both the concepts and the relations between them [19, 20, 21].

A Venn Diagram is a visual organizer used to compare and contrast concrete concepts. It is useful in visually organizing related information about concrete concepts in a structured manner that facilitates recall by showing the similarities and differences between concrete concepts, as it is shown in Fig. 3.

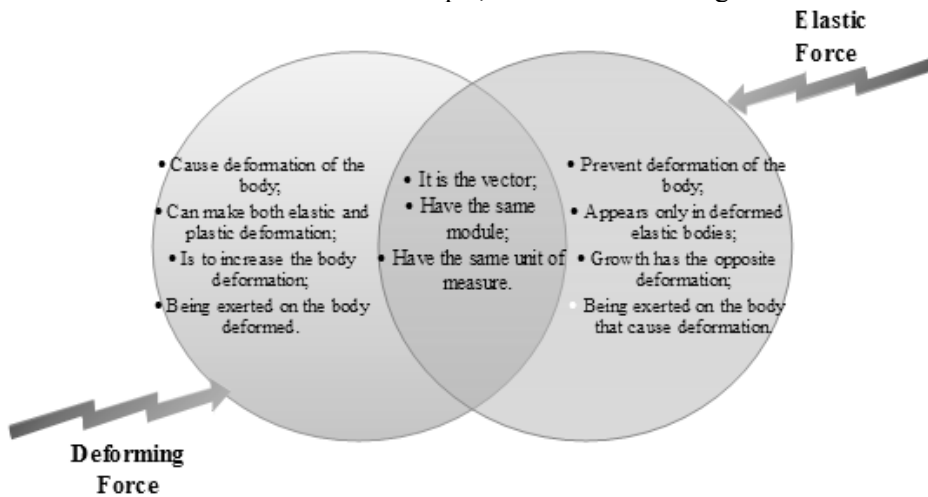


Fig. 3 – Venn Diagram “Deforming Force – Elastic Force”.

2. THE EXPERIMENTAL APPROACH OF DIFFERENTIATED INSTRUCTION ACCORDING TO STUDENTS' READINESS AND LEARNING PROFILE

The hypothesis of the research: The differentiation of the instruction within the process, according to students' readiness and learning profile, can ensure a significant increase of the efficiency of learning Physics and implicitly of the motivation for studying this subject.

2.1. COLLECTING AND ANALYZING DATA

150 students took part in this study run in Bucharest during the school year 2008-2009, out of which 41 secondary school students (two 6th grade classes), 53 high school students (two 9th grade classes), technological profile – services and 56 high school students (two 9th grade classes), sciences profile.

The study of Physics begins in the 6th grade for the gymnasium and respectively in the 9th grade for the high school. At this stage the teacher begins to know his students' characteristics, interests and skills. For an efficient organization of the teaching-learning process it is necessary that the teacher should know his students' learning style preferences.

The first step of this study was the identification of the learning style preferred by students: Visual, Auditory or Kinesthetic. This was possible by applying "Learning Styles Inventory" questionnaire.

The second step of this study was making the pairs of equivalent classes: 3 experimental classes and 3 control classes initially considered to be of equivalent level.

The study was run on Physics, chapter "Forces – Types of forces" at all six classes.

At the control classes, the methodology of the didactic activities was the ordinary one, the teaching-learning processes going on without being influenced by the experimental variable.

At the experimental classes, the teaching-learning process was characterized by the introduction of an experimental variable: differentiated instruction in process according to students' readiness and learning profile, the organization of an instruction process based on level groups.

Since the main learning style for the participant classes is the visual one, the following didactic methods were mostly used: the KWL chart (what students know, what students want to learn, what students learnt), Concept Maps and Venn diagram

During the noticing and controlling stage of the study, there were applied some identical written assessments: pre-test and post-test, for the pair experimental and control classes.

For the statistical analysis of the data the average marks obtained at pre-test and post-test, as well as mean values, standard deviation were used, while for the comparison of the average marks the "t"-test in SPSS programme was used, the accepted significance threshold being 0,05.

2.2. RESULTS AND DISCUSSIONS

In this section, we will present the results of the experimental and control classes at their pre-test and post-test.

Tables presented contain: number of subjects (n), mean, standard deviation (SD), "t" test results (t) and significance threshold (p).

Table 1

Test results concerning the comparison of pre-test mean of the groups

Groups	n	Mean	SD	t	p
Control group (secondary school)	21	7.25	1.54	.026	0.979
Experiment group (secondary school)	20	7.23	1.60		
Control group (high school, profile – sciences)	28	6.60	1.50	-1.55	0.878
Experiment group (high school, profile – sciences)	28	6.66	1.51		
Control group (high school, profile – services)	26	6.70	1.58	.103	0.919
Experiment group (high school, profile – services)	27	6.65	1.57		

By analyzing the data from Table 1 we notice that the difference between the average marks obtained at pre-test by the experimental-control classes is not significant ($p > 0.05$), which allows us to consider them being initially equivalent.

Table 2

Test results concerning the comparison of pre-test-post-test mean of the control and experiment groups

Groups	n	Mean	SD	t	p
Control group (secondary school)	21	-.012	.28	-.195	0.847
Experiment group (secondary school)	20	-.93	.70	-5.760	.000*
Control group (high school, profile – sciences)	28	-.08	.26	-1.780	.086
Experiment group (high school, profile – sciences)	28	-.83	.34	-12.901	.000*
Control group (high school, profile – services)	26	-.06	.18	-1.895	.070
Experiment group (high school, profile – services)	27	-1.11	.34	-16.543	.000*

* $p < 0.05$

By analyzing the data from Table 2, we notice that the progress of the control classes is not significant, ($p > 0.05$), while the progress of the experimental classes is highly significant ($p < 0.05$).

Table 3

Test results concerning the comparison of post-test mean of the groups

Groups	<i>n</i>	Mean	SD	<i>t</i>	<i>p</i>
Control group (secondary school)	21	7.26	1.49	-2.085	0.044*
Experiment group (secondary school)	20	8.17	1.19		
Control group (high school, profile – sciences)	28	6.72	1.47	-2.026	0.048*
Experiment group(high school, profile – sciences)	28	7.50	1.39		
Control group (high school, profile – services)	26	6.89	1.55	-2.055	0.045*
Experiment group (high school, profile – services)	27	7.76	1.54		

By analyzing the data from Table 3, we notice that the difference between the average marks obtained at post-test by experimental-control classes is significant ($p < 0.05$).

It is very interesting to notice the progress of those students who have a school failure risk, meaning students who have obtained marks under 5 at the pre-test and post-test.

Table 4

Marks under 5 at the pre-test and post-test

Groups	<i>n</i>	Pretest Marks<5	Posttest Marks<5
Control group (secondary school)	21	2	2
Experiment group (secondary school)	20	2	-
Control group (high school, profile – sciences)	28	4	3
Experiment group (high school, profile – sciences)	28	4	1
Control group (high school, profile – services)	26	4	2
Experiment group (high school, profile – services)	27	4	1

By analyzing the data from the Table 4 we notice that in the case of experimental classes, the number of the students who have a school failure risk has significantly decreased compared to the control classes

Correlating the results from Tables 2, 3 and 4 we can state that the evolution of the experimental classes was superior to the evolution of the control ones, which proves the efficiency of differentiate instruction, according to students' readiness and learning profile, fact that confirms the hypothesis of the research.

3. CONCLUSIONS

Educational content plays an important role in raising and maintaining students' interest for the study of Physics.

It is also very important the way in which this content is taught to the students. There are more aspects that the teachers should take into consideration in their didactic intercession, so that it should end positively for the partners involved in this process: teacher-student.

First of all, a teacher's role should be to stimulate curiosity, to motivate and to build self-confidence regarding Physics.

Further on, teachers can make a large difference to their students' enthusiasm for a subject, as well as directly influence their students' achievements.

Teachers' subject and pedagogical content knowledge, alongside with their teaching style, are vital factors, but it is often their enthusiasm that captures a student's interest and motivates him/her to study a subject [2].

Important steps should be taken in order to eliminate negative stereotypes and to use some methods that promote equal opportunities for all students so that they should capitalize the whole potential.

It is old-fashioned the idea according to which the use of a large variety of didactic methods within the teaching-learning process ensures the best efficiency.

There should be selected those methods that give to each student the possibility to acquire the contents and to accomplish his tasks according to his possibilities, his needs and rhythm of learning.

These actions must be carried out by the teachers since the first years of studying Physics, respectively the 6th grade and the 9th grade, based on the following grounds: positive contacts with Physics at an early age can have long-lasting impact over the interest and motivation for studying this subject, and this is also the period when children build their personal set of values and goals and the representation of their future career.

This is why we have chosen the pedagogical experiment described in the present paper to be carried out at the 6th and 9th grade. Furthermore, the chapter "Forces – Types of forces" was not selected by chance, since it is representative for the study of Physics with strong interdisciplinary connections.

For an efficient planning of the instruction it is absolutely necessary that the teacher should know his students' learning profile. Therefore, a questionnaire can be applied, the Visual Auditory Kinesthetic Model, in order to determine the learning styles preferences for the students in the 6th and 9th grade.

These aspects being clarified, the teacher can afterwards differentiate the instruction process according to the content, process or product.

In this paper there have been studied the effects produced by the differentiation within the process according to the student's readiness and learning profile. For the visual learners the methods used were: Concept Maps and Venn diagram. The use of these graphic organizers is beneficial because it develops in students cognitive capacities (identification, examination, defining, interpretation, correlation, formulation, construction; evaluation and self-evaluation capacities); team work abilities; critical and creative thinking.

The results of the study presented in this paper prove that the differentiate instruction can ensure the increase of the school performance and implicitly of the motivation for studying Physics.

If from the beginning the students' efforts are directed towards selecting and combining certain methods that should focus on stimulating their own activity and on their effective participation, considering their own possibilities and rhythm, the objective is accomplished [22].

REFERENCES

1. Report by High Level Group on Science Education, *Science Education Now: A renewed Pedagogy for the Future of Europe*, 2007; <http://ec.europa.eu>, 3, 8.
2. Report by the High Level Group on increasing Human Resources for Science and Technology in Europe, *Europe needs more scientist*, 2004; <http://ec.europa.eu>, 8, 69, p. 117, 145.
3. Global Science Forum, *Encouraging student interest in science and technology studies*, OECD, 2008, 65, 98.
4. M. Ionescu, I. Radu, *Modern didactics*, Dacia Publishing House, Cluj-Napoca, 2001, p. 126.
5. J. Osborne, *Attitudes towards science: a review of the literature and its implications*, Int. J. Sci. Education, **25**, 1049–1079 (2003).
6. I. Nicola, *Pedagogy*, Didactic and Pedagogical Publishing House, Bucharest, 1992, p. 272.
7. C. Cucos, *Pedagogy*, Polirom Publishing House, Iasi, 2006, pp. 282–283.
8. I. Cerghit, *Alternative and complementary instruction systems*, Polirom Publishing House, Iasi, 2008, p. 67.
9. A. Benjamin, *Differentiated instruction*, Eye on Education, Larchmont NY, 2003, p. 1.
10. C. A. Tomlison, *Mapping a Route Toward Differentiated Instruction*, Educational Leadership, **57**, 12–16 (1999).
11. C. A. Tomlison, *Differentiation of Instruction in the Elementary Grades*, ERIC DIGEST, 2000; <http://ceep.crc.uiuc.edu>.
12. C. A. Tomlison, *The differentiated Classroom: Responding to the Needs of All Learners*, ASCD, USA, 1999, 15.
13. M. Sprenger, *Differentiation Through Learning Styles and Memory*, Corwin Press, SAGE, London, 2008, 3.
14. S. S. Northey, *Handbook on Differentiated instruction For Middle and High Schools*, Eye on Education, Larchmont NY, 2005, p. 75.
15. D. P. Ausubel, *The Acquisition and Retention of Knowledge: A Cognitive View*, Kluwer Academic Publishers, Boston, 2000, pp. 125–128.
16. M. Ruiz-Primo, *Concept Maps: Theory, Methodology, Technology*, Proceedings of the First International Conference on Concept Mapping, **1**, 555–562 (2004).
17. K. R. Butcher, *Learning from text with diagrams: Promoting mental model development and inference generation*, Journal of Educational Psychology, **98**, 182–197 (2006).
18. C. A. M. Van Boxtel, J. Van der Linden, E. Roelofs, G. Erkens, *Collaborative concept mapping: Provoking and supporting meaningful discourse*, Theory into Practice, **41**, 40–46 (2002).
19. F. Fischer, J. Bruhn, C. Gräsel, H. Mandl, *Fostering collaborative knowledge construction with visualization tools*, Learning and Instruction, **12**, 213–232 (2002).
20. D. H. Robinson, S. L. Robinson, A. D. Katayama, *When words are represented in memory like pictures: Evidence for spatial encoding of study material*, Contemporary Educational Psychology, **24**, 38–54 (1999).
21. J. Van Drie, C. Van Boxtel, G. Erkens, G. Kanselaar, *Using representational tools to support historical reasoning in computer-supported collaborative learning*, Technology, Pedagogy and Education, **14**, 25–42 (2005).
22. L. Dinescu, M. Dinica, C. Miron, *Active strategies - option and necessity for teaching science in secondary and high school education*, Procedia Social and Behavioral Sciences, **2**, 3724-3730 (2010).