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Application of Differentiated Teaching in Applied Sciences in Secondary Education

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Abstract

Nowadays, differentiation in teaching is considered to be a given fact on all levels of education. Responding to the needs of all students in a class with various needs constitutes a

major challenge. The weakness on the teacher's part to deal with different students on different cognitive levels leads to their failure at school and to all the negative results that arise from it. Differentiated teaching and learning contributes to the dealing of the problem maintaining at the same time the respect to different levels of knowledge existing in the class and responds to the needs of every student.

The present article presents a case study where a group of Technology teachers and an expert on the development of a curriculum developed and applied a differentiated learning environment of teaching on the third grade of secondary school in two secondary schools in Greece. This study proves that differentiated teaching has a positive impact on the involvement and motivation of students and improves their understanding difficult meanings of applied sciences.

Keywords: Differentiated teaching, Natural sciences, Virtual workshops, Applied sciences

1. Introduction

Differentiated teaching is constantly gaining ground in numerous educational circles as part of the effort to serve more and more different classes. The present article deals with a case study relating to the application of differentiated teaching in a course to secondary students entitled: «I learn through a project». Discussions have been conducted with the secondary school teachers of 20 students aged 13 who participated in the study during the educational program. The discussion in this project is based on the researcher's and the secondary teacher's observations as well as on the descriptive evaluations of the students' learning. Findings show that differentiated teaching promoted the creative thinking and writing skills of the students to a smaller or larger extent, depending on the linguistic level of the students. These findings provide us with the possibility to support the application of differentiated teaching in the process of learning.

There is a limited number of studies that examine the prerequisite skills, beliefs, knowledge and experience of the students upon which they will be able to build the new knowledge (Fykholm & Glasson, 2005). In our study a complete teaching approach to Science, Technology, Engineering and Maths (STEM) is presented for the formation of a differentiated educational intervention so as to imprint the positive or negative role of this method.

Teaching applied sciences on the part of the teachers is a complicated and manifold process. On the one hand, emphasis should be placed on the development of teaching skills for effective teaching. Teachers should take the single differences that relate to learning (that means forms of learning and learning according to need) into consideration and design appropriate teaching strategies to enhance the probabilities of academic achievement for every student. On the other hand, it is expected that the teaching process that is developed in various learning ways, will lead to the development of differentiated teaching approaches which could have a positive impact on more effective learning. There has recently been an interest in researching these forms of learning (Arslan, Gocmencelebi, & Taipan, 2009, Birenhaum & Rosenau, 2006, Okur & Bahar, 2010, Erdem, Akkoyunlu, & Yilmaz, 2010, Peker & Miraseyedioglu, 2008).

It is believed that skepticism over various styles of learning could help teachers evaluate the different skills of every student that relate to learning (Sloan, Daane, & Giesen, 2004, Tripp

& Moore, 2007).

Over the last decades, significant research has focused on detecting the relationship between teaching strategies, learning forms and academic achievement in higher education mainly (Akdemir & Koszalka, 2008, Arthurs, 2007, Bidabadi & Yamat , 2010, Contessa, Ciardello, & Perlman, 2005, Kiguwa & Silva, 2007, Kolb & Kolb, 2005, Naimie, Siraj, Piaw, Shagholi, & Abuzaid, 2010). More specifically, certain studies have shown that the agreement between teaching strategies and learning forms fortifies the students' academic achievements (Beck, 2001, Felder & Brent, 2005, Rogers, 2009) and positive attitudes on the part of the students are formed regarding the contents of the course (Fox & Bartholomae, 1999). On the contrary, other studies report the fact that the mismatch between teaching strategies and learning styles have a negative impact on both academic achievement as well as attendance of the course on the part of the students (Felder & Henriques, 1995).

From our knowledge so far about the Greek educational system, there is a lack of research as far as the adjustment of teaching strategies with learning forms for the teachers of secondary schools is concerned. The Greek Ministry of Education applied the required educational reformation from the Declaration of Bologna to the educational system. One of the main directions of this reformation has as its goal to promote a curriculum centered on the student through flexible and differentiated teaching regulations and the development of skills through life learning (Singer & Sarivan, 2006). Within this framework, the most appropriate teaching methods for every learning style are being defined and represent, according to our opinion, a proper way of responding to the high demands and needs of learning of our students. Moreover, study results that concerned teachers in Romania (Tulbure, 2010) revealed that the needs of the students must be examined separately. They must be handled as developing personalities with separate needs that should be recognized and reevaluated within the educational process.

1.1 Report of the Problem

Students' achievements in the field of Technology have been low throughout the years. This is attributed to many factors such as insufficient facilities, the students' bad attitude towards the subject of Technology, their weakness to correlate and organize material with the lapse of time and the inappropriate teaching strategies. Moving from the conventional teaching methods to innovative strategies such as the constructivist approach, the discovering learning technique and learning based on solving problems are being applied in order to deal with these educational needs.

1.2 Aim

The aim of the study is to define whether there is a difference between the students who learn a specific subject matter through differentiated teaching and those who learn through the conventional teaching approach.

1.3 Hypothesis

Statistically, there is no significant difference between the students exposed to differentiated teaching and those exposed to conventional teaching as far as the students' performance in the subject of Technology is concerned. Also enriching digital teaching is more intimate as a way of presenting new knowledge to students. Finally, teachers are not open to applying

differentiated teaching styles.

2. Methodology

The study included an experimental design that allows the researchers to randomly select a sample of the population and do not require the random delegation of single cases to the groups being compared. It also allows the researchers to conduct studies in real life natural regulations using probability samples. It includes the study of more than one samples often for a long period of time.

Our study used an experimental design to implement the intervention (Nachmias & Nachmias, 2004). The school was selected on the basis of the infrastructure criterion, that is, to be able to support our intervention with laboratory material. The students who participated in the research were studying in the second grade of the Gymnasium. Students from 5 classes of 20 students participated. Students are unaware of their involvement in the action, so we can avoid exchanging opinions with each other by reducing the validity of the research.

The researchers used a test which was distributed to the control and the experiment groups and was corrected by the teachers who teach the subject. After that, students of both groups attended the class where the unit of Ohm's Law was taught. The control group attended the class in the conventional way whereas the experiment group in the differentiated way. The teachers that followed the differentiated method were previously informed by the researchers about the way and the realization of this kind of teaching. The material needed for the differentiated intervention were the ones already existing in the school lab. Characteristically, we report arduino boards, led, connection cables etc. already being part of the lab equipment. In that way, revealing the experiment to the students subjected to it has been avoided. Thus, designing provides the researcher with the expectation to receive the study results as it is protected against internal and external validity threats.

Group A1 received an initial test T1 where the level of the students' knowledge on the subject matter was evaluated. Afterwards, the students received the subject matter O through differentiated teaching and eventually, after being given feedback, answered the test (T2). The group B1 also received an initial test T1 where the level of the students' knowledge in the subject matter was evaluated. The students then followed the subject matter in the conventional method C and lastly, they were given a test T2 where the rate of assimilation of the new knowledge was evaluated.

The different combinations of tested and non-tested groups with experiment and control groups allow the researcher to ensure that the confusion variables and external factors have not affected the results (Spector, 1981). The preliminary and metacognitive control was being treated as a regular process through which the students were put. The experiment and control groups were from different schools in order for the interaction of topics to be avoided. The students were taught by their teachers so as not to recognize the experiment.

The stratification random sampling technique was used to select the schools and include them in the sample of student groups. With the stratification sampling technique, the statistical accuracy is higher because the variability within the sub-groups is lower in comparison to the variations in the student population (Mugenda & Mugenda, 1999). The population was divided into groups using a specific criterion. Then, a number of data was randomly selected

for every sub-group. The criterion or variable used for the stratification was the gender because it had two categories, high school boys and girls. Simple random sampling was used for every category concerning the selection of schools involved in the study. Simple random sampling was also used for allocating schools to experiment and control groups. This was done to avoid the influence and input of prejudices in selecting the schools. The test used was based on the Maths Achievement Test. (MAT). The test is composed of questions that cover knowledge, understanding, application and analysis of natural sciences in the chapter of electricity and in the unit of Ohm's Law. The test had 12 questions with a total score of 60. The test was expected to present its efficiency through the exploitation of the differentiated teaching approach.

3. Results

The results of the Achievement Test of the laboratory exercise were analyzed in order to define the emerging influence of differentiated teaching on the students' performance in Technology.

The students' improvement from their initial knowledge until the test was compared and then again from the test until the experiment and control group. It was discovered that there were no students who had not experienced any decrease in their achievements in the course after the test. 89 %of the students presented improvement in their understanding of the subject matter under study in the field of technology they were taught. The largest percentage of the students (89 %) in the experiment group that was taught through the differentiated teaching approach performed better in the posttest than in the pretest. As she says (Tulbure, 2011) in her research, students who attended a differentiated intervention in the positive sciences performed better on comprehension than students on the traditional course. Result which agrees with our research. This means that there has been an improvement of the students of the experiment group in the course they followed through differentiated teaching. The findings of the study agree with the conclusions of Goddard and Goddard (2007) that showed that differentiated teaching, when fully applied, can greatly improve the students' achievements. The findings, also, agree with Lewis &Bates (2005) who support that most students have the opportunity to reach academic success in class where instructions are being differentiated.

There has been a comparison of the students' improvement from the point of pre-selection up until after the test. Data for Table 1 show the average scores and the average profit gained from the students in A1 experiment group and B1 control group in the test.

Table 1. Average scores and average profit obtained by the students in the test

Total	**A1**	**B1**
N	**78**	**85**
Average score after the test	**70.26**	**41.67**
Average score before the test	**17.35**	**12.25**
Average profit	**52.91**	**29.42**

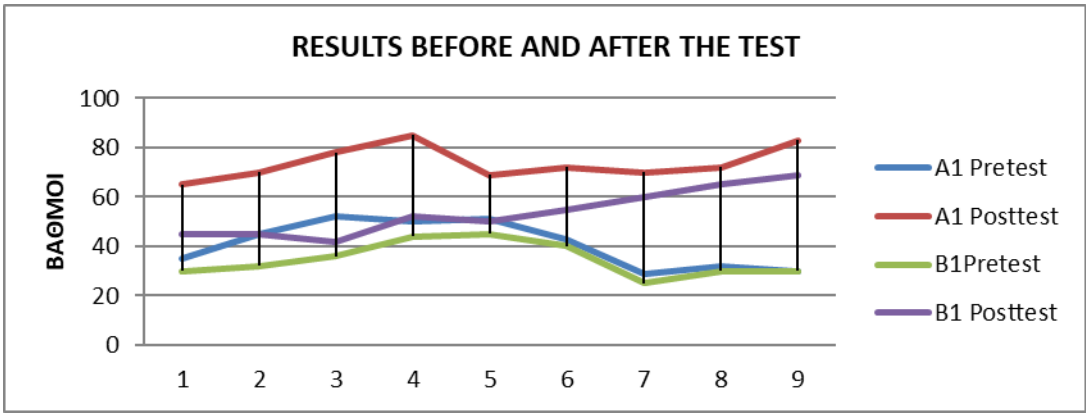
A1-experiment group before and after the control, B1-control group before and after the control.

The results on Table 1 show that the average scores after the test for the A1 experiment and B1 control groups were 70,26 and 41,67 respectively. The average score of the experiment group, which has been exposed to differentiated teaching, was higher than the average score for B1 control group which has been taught in a usual teaching manner. The average scores before the test for the A1 experiment group and B1 control group were 17,35 and 12,25 respectively. The results on Table 1 show that the A1 experiment groupscored an average profit of 52,91 and the B1 control group a 29,42. This means that A1 had a higher average profit and thus, scored more in its goals than B1.

In that way, A1 group, which was taught through differentiated teaching, had a higher average profit score than B1 control group which was taught in a conventional manner. The experiment group increased its scores to a higher rate than the control group. This entails that the use of differentiated teaching improves academic results in the course and the educational benefits could help students catch up in certain areas required so as to be promoted to the next level. The findings of the study were according to Hodge (1997) who realized that students who prepared for tests following differentiated instructions, showed statistically more significant profits in their academic performance.

The results were also compatible with Koutselini and Gagatsis (2003) who discovered that differentiated teaching facilitated the building of knowledge of the students through the process of maximization of motivation for cognitive and post cognitive development that will eventually improve all students' academic results. The conclusions, also, coincide with Tieso's findings (2002) who supports that the success profits lie in the achievements through results before/after the test for the students in effectively differentiated teaching environments.

The interaction between pretest and posttest for the students in the experiment group and control groups is presented in Graph 1.



Graph 1. Graphic depiction of the students' success of both groups before and after the test

A1- experiment group before and after the control.

B1- control group before and after the control.

Information in Graph 1 show the achievement line of the average results of the students in the experiment and control groups. The difference between the average scores of the groups is

shown in the inclination of the achievement line. The average score of the experiment group students started slightly above the one of the control group during the preliminary process. In the posttest, the average score for the experiment group was way higher than that of the control group. The inclination of the achievement line of the experiment group was bigger than that of the control group, suggesting that the progress noted in the experiment group was significantly greater than the progress noted in the control group in the test.

This means that differentiated teaching unfavorably enlarges the gap concerning achievement between experiment and control group students. When students follow courses through differentiated teaching, they achieve considerably better results. The results agree with the findings of the McAdamis research (2001) that showed considerable academic improvement from low academic results after the application of differentiated teaching. The results also agree with Brimijoin's findings (2001) who reports that there is proof of significant learning achievement and gain in a trial for students who interact within an effectively differentiated classroom.

Data on Table 2 show the average scores taken after the trial when students were exposed to differentiated teaching in experiment groups and to conventional teaching methods in control groups.

Table 2. Average score after the trial for experiment and control groups

Total	**N**	**Average value**	**S.D.**
Experiment group	**78**	**68.17**	**16.87**
Control group	**85**	**34.79**	**19.89**

The results on Table 2 show that the average score of the experiment and control group students for the control after the test was 68,17 and 34,79 respectively. The average score of the experiment group, which was taught through differentiated teaching, was twice as much as the average score of the control group. The test results were encouraging. The results show that the use of differentiated teaching promotes the students' success as the students exposed to it perform better in the required trials than those exposed to conventional teaching methods. Differentiated teaching provides with learning environments that maximize the potential success of the students. The results agree with the Kim research findings (2005) that presented elements of positive results in the students' achievement when exposed to differentiated teaching. The results also agree with Tieso (2005) who claims that students taught through differentiated teaching reached significantly higher goals in their scores after the examination than those exposed to conventional teaching methods.

An independent trial procedure t-test was used in order to examine the hypothesis to define whether there has been a statistically important difference in average scores between experiment and control groups. The data on Table 3 shows the comparison of average scores of the posttest experiment with the ones of the t-test.

Table 3. Trial t-test concerning the exposure to differentiated teaching and conventional teaching approach

Total	N	AVERAGE	S.D.	t-value	t- critical
Experiment group	78	68,17	16,87		
Control group	85	34,79	19,89	3,23	1.96

The results on Table 3 show that t-value is higher than t-critical (value= 3,23 and critical= 1,96 p 0,05). Thus, the difference between the two groups is important on the level of trust 5 % and the zero difference was overruled. The analysis of the t- test results reveals that the statistical media are different on the level a=0,05 and that there is a difference between the average scores of the experiment and control groups. There is a statistically big difference in the achievement in the course of Technology between the students exposed to differentiated teaching and those exposed to conventional teaching approaches. This means that differentiated teaching significantly improves the technological achievements of the students in the class.

The results coincide with Tieso (2005) who reached the conclusion that differentiation in the curriculum, along with the creation of flexible group teaching, can significantly improve the students' technological achievements. The results are, also, compatible with the findings of Brighton, Hertberg, Moon, Tomlinson & Callahan, (2005) who ascertained that students in differentiated secondary school classrooms have shown statistically more important results than those students in the control groups. The results, also, coincide with Ferrier's findings (2007) who believes that students in differentiated teaching classrooms were found to get considerably higher grades than their peers, who were taught in a traditional manner.

After correlating the results of Table 2 that show that the average of the experiment group is higher with the results of Table 3 that show that there is a statistically considerable difference in the average scores of both groups, it shows that the progress of the experiment group was better than the one of the control group which, in turn, proves the efficiency of differentiated teaching. This means that differentiated teaching reinforces the students' achievements and leads to higher levels of accomplishment in the experiment groups. The results agree with Lim's findings (2005) that showed that differentiation in a subject often translates into improved learning achievements because of positive correlation, appropriate academic activities and high accomplishments. The results coincide with Ladson & Billings (1994) who reached the conclusion that the curriculum and the teaching that match the students' learning style and preference have positive effect on learning results. The findings are, also, compatible with Sternberg (1997) who reached the conclusion that ,when the students match the instructions and their learning preferences, they achieve considerably more than those students whose teaching does not match their learning preferences.

4. Conclusions

The findings of the study demonstrated that differentiated teaching is more profitable for the improvement of learning results. Having examined the collected data, it was defined that the use of differentiated teaching has a positive effect on the students' achievements in the course of Technology. The application of differentiated teaching has a positive impact on the

students' achievements. Students taught through differentiated teaching performed better than those exposed to conventional teaching methods. Differentiated teaching is a highly promising approach for the support of the students' various needs as it steadily affects their performance. The conclusions of this study encourage the application of differentiated teaching as it greatly benefits students, who may struggle in the classroom to understand the subject matter. Not only their strong points but also their weaknesses are brought out within an increasingly diverse learning environment. Differentiated teaching is an effective method of teaching applied sciences as it provides students with practical knowledge, interaction for the solution of real-life problems and more communication opportunities with their classmates in comparison with the conventional teaching approach.

5. Recommendations

Based on the findings and the conclusions reached in the current study, the adoption of differentiated teaching is recommended for courses such as Technology, Electronics etc. Evaluating educational aims of various courses as well as massive restructuring of analytical curricula would have to be realized in order to incorporate the use of differentiated teaching approach in various subject matters. This fact is attributed to the positive influence on achieving goals when differentiated teaching is applied. The authors of analytical curricula should include the differentiated teaching approach when designing the teaching of applied sciences. During the instruction of teachers of the respective specializations, the university institutions should develop and offer programs which use differentiated teaching methods. There should be educational informative meetings and motives for professional advancement should be given to teachers who apply differentiated teaching approaches that require coordinated cooperation among all teachers including the school directors.

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