World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(RESEARCH ARTICLE)

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The study of an innovative Eéducationnel practice in Greek students: The flipped learning

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World Journal of Advanced Engineering Technology and Sciences, 2024, 12(02), 013–020

Publication history: Received on 21 May 2024; revised on 28 June 2024; accepted on 01 July 2024

Article DOI: https://doi.org/10.30574/wjaets.2024.12.2.0275

Abstract

The purpose of this paper is to compare the effectiveness of using flipped teaching against traditional teaching, with active learning techniques, in physics and mathematics courses. The study was conducted on 100 middle and high school students who were first subjected to traditional teaching (control group) and then subjected to flipped teaching (experimental group). To check the effectiveness of the two methods, the students were submitted to an assessment test in the lesson taught with the two methods. To test the existence of a statistically significant difference between the performance of the two groups, the independent sample t-test and ANOVA test were used for continuous variables. In addition, multiple logistic regression analysis with Odds Ratios was used to predict student achievement depending on the teaching method used. The results of the study showed that there is no statistically significant difference in the average performance of students with the two teaching methods.

Keywords: Flipped Learning; Greek Students; Innovative Educational Practice; Science

1. Introduction

Flipped learning is a teaching approach in which the introduction of new teaching concepts is not done at school, as is done with the traditional teaching method, but the students prepare themselves at home by studying appropriate material and websites given to them by the teacher. Then, the lesson process continues at school, now that the students know the content of the lesson, the teacher repeats some points of the lesson and suggests solving problems. Using the knowledge and experience they have gained, students can work cooperatively with their classmates through group activities. In this stage the teacher acts as a mentor, guide, and facilitator of learning, trying to solve problems and questions of his students, trying to develop their interests and abilities of his students [1]. Finally, students can check their knowledge and practice additionally and expand their already acquired knowledge (Fig. 1 and Fig. 2).

Previous studies have shown that the flipped teaching method can improve student academic performance as it emphasizes motivation, autonomy, and self-directed skill development compared to traditional teaching methods [2-4].

Despite these positive results, a barrier to active learning is student resistance. Teachers implementing active learning techniques for the first time may face resistance from students who are unfamiliar with such an approach [5]. Furthermore, a recent study revealed that students prefer low-effort learning strategies – such as listening to lectures – despite performing better with active learning [6].

Proponents of flipped teaching argue that the success of the model is due to its foundation in active learning pedagogy [7-10]. For example, the difference in performance between flipped and traditional classrooms disappears when both use active learning techniques [11], [12]. Jensen, Kummer & Godoy (2015) hypothesize that the key to driving learning

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in the flipped environment is the inclusion of active learning. Additionally, research shows that it is the presence of active learning, and not the flipped instruction structure itself, that leads to higher student achievement [13]. However, as with any technique, active learning is not a panacea. Active learning techniques must be applied alongside consideration of learning outcomes to make the learning process meaningful to the learner [14].

Taking into account all the above, the aim of this work is to compare the effectiveness of using the flipped teaching method against traditional teaching with active learning techniques in physics and mathematics courses.

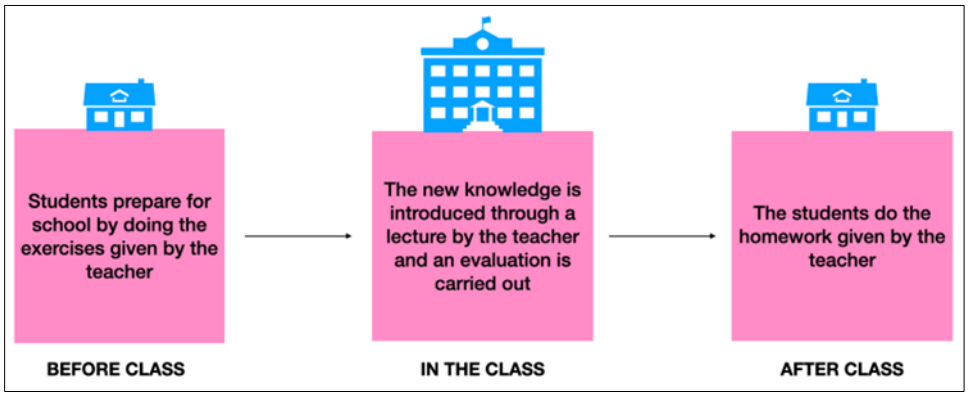

Figure 1 The structure of traditional teaching

1.1. The structure of flipped teaching

Flipped teaching consists of three main stages: (a) before class, (b) in class, and (c) after class (Figure 2). In the first step, the transfer of information is carried out by students who begin to learn in advance. The learning status check is performed in the next step. Finally, the application of knowledge takes place in the last step.

1.1.1. 1st stage: before class

In this step, educators must create instructional materials that enable self-directed learning for students. This material will include PowerPoints, quizzes and lecture notes, as well as online videos. The advantage of this material is that students can control their learning speed based on the student's level, and use this material regardless of time and place. Students pre-read assigned material online and/or textbook.

1.1.2. 2nd stage: in the class

In this step, teachers can give a "quiz" to check the learning status of the first step. This quiz activity can also act as an assessment tool for learning outcomes and checking student performance at the end of class. Teachers follow up with a mini-lecture on a related topic after the quiz activity. In addition, teachers can summarize or provide an additional explanation about the learning material/video content provided for learning in stage 1 (before class). Students then engage in a variety of activities, including group discussion, group work, and peer tutoring [15]. Teachers must monitor each student's learning activities, determine what students do not know through continuous assessment, and act as facilitators of such activities. Teachers at this stage can also perform individualized learning for students with learning disabilities.

1.1.3. 3rd stage: after class

At this stage, teachers give a tutorial to review difficult concepts while students, now working in their own space, can check their knowledge, practice extra and extend their already acquired knowledge.

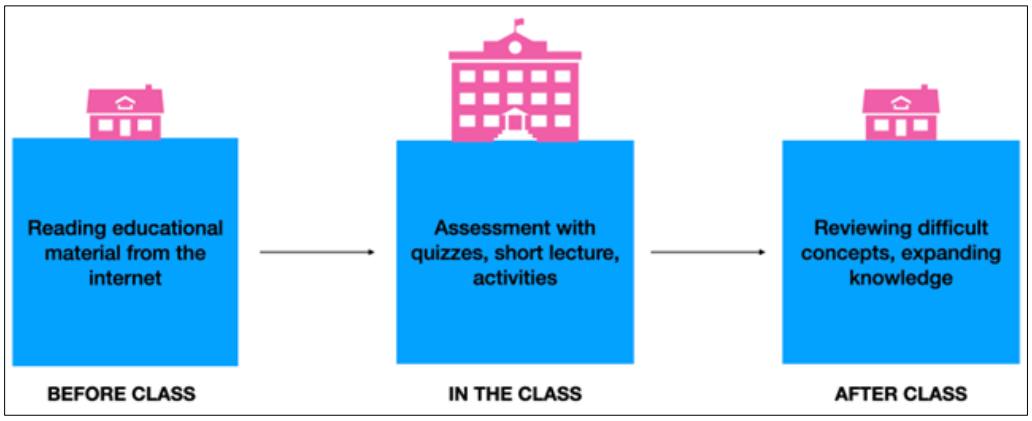

Figure 2 The structure of flipped learning

2. Material and Methods

In order to compare the effectiveness of using the flipped learning method against traditional teaching, with active learning techniques, in physics and mathematics courses, 100 middle and high school students participated in this research in the period 09/2023 to 12/2023 (First quarter of the 2023-2024 school term). The students were first subjected to traditional teaching (control group) and then subjected to flipped teaching (experimental group). The traditional teaching was carried out with active learning methods, i.e. the students were asked to learn the new material by writing in their notebooks the definitions given to them from the board, followed by a short lecture - explanation of the new concepts - and then participated in group activities, solving exercises. The flipped teaching was carried out by watching videos from the internet, with the help of which the new material was introduced to the students. Then the students were submitted to an assessment test-Quiz- to check the effectiveness of the two methods. To test the existence of a statistically significant difference between the performance of the two groups, the independent sample t-test and ANOVA test were used for continuous variables. A t-test is an inferential statistic used to determine if there is a significant difference between the means of two groups and how they are related [16]. In this way, it was checked if there is a statistically significant difference between the two methods flipped teaching-traditional teaching from the performance of the students in the quiz. Moreover, to test the existence of a statistically significant difference between each student's performance (excellent, very good, etc.) with the 2 different teaching methods an ANOVA test was used. Analysis of variance (ANOVA) is a statistical technique used to check if the means of two or more groups are significantly different from each other [17-28]. In addition, multiple logistic regression analysis [17-28] with odds ratios (ODDS RATIO) was used to predict student performance depending on the teaching method used. More specifically the OR or ODDS RATIO has been used to compare the relative probabilities of occurrence of the outcome of interest, given the exposure to the variable of interest [17-28]. That is, it compares the probabilities of each student's performance (excellent, very good, etc.) given the exposure to the teaching method (flipped learning or traditional). Table 1 shows the methodology followed with both teaching methods. Statistical analysis was performed using the IBM SPSS 27 software package for Windows.

Table 1 Research Methodology

Teaching Method	**Traditional**	**Flipped learning**
Before Class		E-learning (Reading educational material through internet)
Inside the class	The knowledge was transfered with active learning activities-solving exercises	Active learning through group activities
After class	Problem solving	
Assessment	Test	Test

3. Results

Figure 3 shows the gender distribution of the sample of 100 students. As can be seen from Figure 3, 63% of the students were girls, while 37% were boys. Figure 4 shows the student's performance on the assessment quiz given to them after both the traditional and flipped teaching methods. As can be seen from Figure 4, 31% of students in both traditional and flipped teaching methods had an excellent performance (score from 18.5 to 20) on the assessment quiz. 47% of the students in the traditional teaching had a very good performance (grade from 15.5 to 18.4) on the assessment quiz, while only 31% of them had a corresponding performance in the flipped teaching. 11% of the students had a good performance (grade from 12.5 to 15.4) in the traditional teaching while 14% of them had a corresponding performance in the flipped teaching method. 8% of the students had a moderate performance (grade from 10 to 12.4) in the traditional teaching while 21% of them had a corresponding performance in the flipped teaching method. Finally, 3% of the students had insufficient performance (grade from 1 to 9.9) both in the traditional and inverted teaching methods.

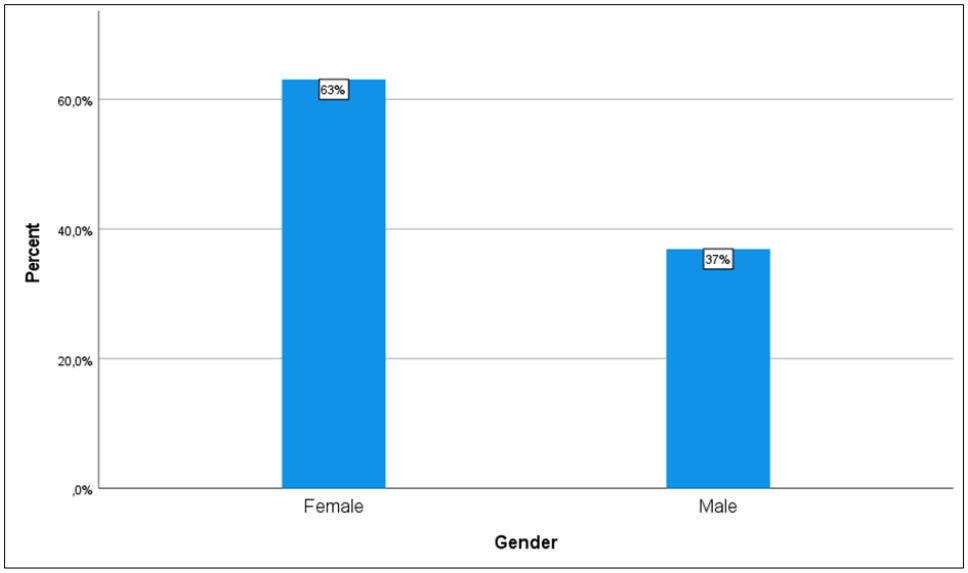

Figure 3 The gender of the sample of 100 students

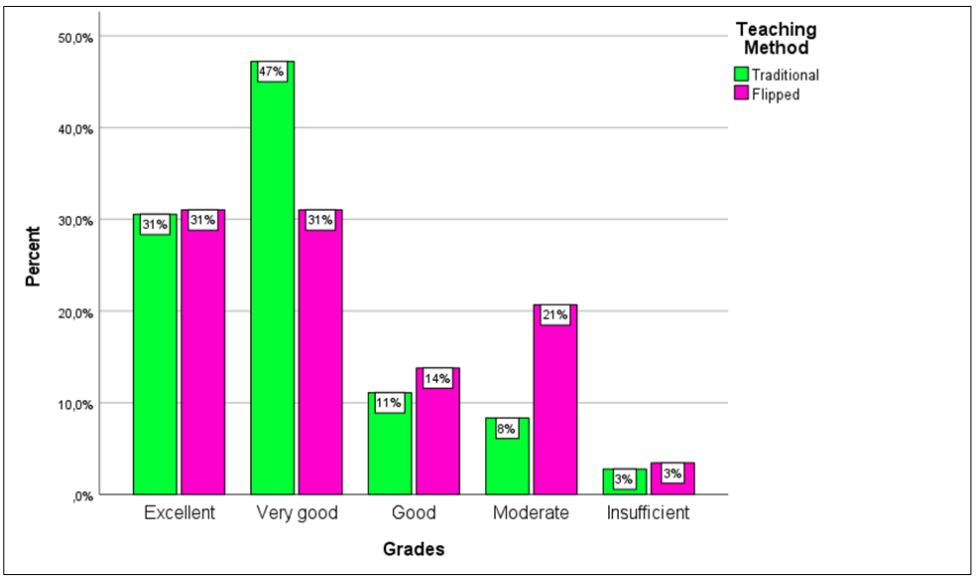

Figure 4 The student's performance with the two teaching methods

Table 2 shows the results from the independent sample t-test, which was performed to test the existence of a statistically significant difference between the performance of the two groups of students, the control group (students who received traditional instruction) and the experimental group (students who received flipped instruction) in physics class. The null hypothesis that the two teaching methods do not differ from each other in terms of average student achievement was tested against the alternative hypothesis that the two teaching methods differ from each other in terms of average student achievement as shown below:

- H_0: The two teaching methods do not differ from each other in terms of students' performance in the physics course
- H_1: The two teaching methods differ from each other in terms of students' performance in the physics course

As can be seen from Table 2, the p-value is equal to 0.303 (p-value>0.05), which indicates that we accept the null hypothesis, that is, that there is no statistically significant difference in the average performance of students with the two teaching methods.

Table 2 Independent sample t-test, in physics

Teaching method	Mean of grades	p-value
Traditional	18.3	0.303
Flipped learning	17.6	

Table 3 shows the results from the independent sample t-test, which was performed to test for the existence of a statistically significant difference between the performance of the two groups of students, the control group (students who underwent traditional instruction) and the experimental group (students who underwent flipped instruction) in the math class. The null hypothesis that the two teaching methods do not differ from each other in terms of the average performance of the students was also tested here against the alternative hypothesis that the two teaching methods differ from each other in terms of the average performance of the students as shown below:

- H_0: The two teaching methods do not differ from each other in terms of students' performance in the math course
- H_1: The two teaching methods differ in terms of student's performance in the math course

As can be seen from Table 3, the p-value is equal to 0.555 (p-value>0.05), which indicates that we accept the null hypothesis, that is, that there is no statistically significant difference in the average performance of students with the two teaching methods.

Table 3 Independent sample t-test, in mathematics

Teaching method	Mean of grades	p-value
Traditional	19.1	0.555
Flipped learning	18.7	

Table 4 shows the results from the ANOVA test (Analysis of variance). We observe that the p-value is 0.588 which indicates that the result is not statistically significant (p-value>0.05).

Table 4 Anova test

Student Performance	Number of students	p-value
Insufficient	3	0.588
Moderate	14	
Good	12	
Very good	41	
Excellent	30	

Table 5 shows the results from the multiple logistic regression analysis. We notice that the largest Odds Ratio is 2 which indicates that students are 2 times more likely to perform moderately in physics and mathematics when taught using flipped learning compared to traditional instruction. However, the p-value is 0.563 which indicates that the result is not statistically significant (p-value>0.05).

Table 5 Multiple logistic regression

Student Performance	Number of students (Control group)	Number of students (Experimental group)	ODDS RATIO	p-value
Insufficient	3	3	1.0	0.563
Moderate	8	20	2.0	
Good	11	14	1.0	
Very good	48	32	0.5	
Excellent	30	31	0.8	

4. Discussion

The purpose of this work was to compare the effectiveness of using the flipped learning method against traditional teaching, with active learning techniques, in physics and mathematics courses. The results showed that there is no statistically significant difference in the average performance of the students with the two teaching methods. Other researchers have found similar results in mathematics. More specifically, in [29] the authors argue that although students who underwent flipped teaching showed higher self-efficacy, no significant difference was observed in their mathematics performance.

Additionally, in a recent study, [30], the researchers interviewed students and found that some problems arose with the flipped teaching method. First, the important contact with students and teachers is difficult to replace with video. Second, forgetting or neglecting to prepare not only makes it difficult for students to participate in the class but can irritate other members of the class. Third, students experience anxiety when they fail to understand the task or film they are supposed to use when preparing for class.

The use of flipped teaching is indicated as a tool only for specific tasks. It can be applied to parts of a lesson if the teacher takes care to ensure that all students achieve their goal. The use of flipped teaching as a pedagogical approach for full middle and high school courses does not appear to be appropriate.

However, the main advantage of flipped teaching lies in the fact that it emphasizes the idea of active participation of students having already studied lectures/videos, which is closely related to the learning approaches that have been referred to as active learning, student-centered learning and based on the problem. "Active learning" is generally defined as any teaching method that involves students in the learning process. In short, active learning requires students to do meaningful learning activities as well as think about what they are doing.

In addition, social interactions are the basis for achieving active learning [31] and become the main source for achieving success in education. Interaction is a two-way process of communication between parties. Interaction with peers can improve students' motivation and interest and help them pursue different ideas in depth and enhance their learning outcomes. Interaction with classmates motivates students to discuss and share ideas and information.

In the present research, the connecting link between the two teaching methods, traditional and flipped, is the presence of active learning and social interaction between students. In traditional teaching, active learning took place after the introduction of new material, through exercises that students were asked to solve by participating in group activities. In flipped teaching, active learning took place after the introduction of the new material via the internet before introducing the students to the classroom through group activities and cooperative learning.

Thus, the results of this paper support previous research [32], [33] which concluded that the difference in performance between flipped and traditional classrooms disappears when both use active learning techniques.

5. Conclusions

This study represents an important contribution, especially regarding the application of flipped teaching in physics and mathematics courses. It emerged that although flipped teaching emphasizes students' motivation, autonomy and self-directed competence development, it cannot replace the traditional teaching method, especially when the latter is applied with active learning techniques.

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