



The impact of flipped learning versus typical learning on students' cognitive performance in a new technology physical education course

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Abstract

The purpose of this study was to evaluate the effectiveness of a flipped learning approach in delivering the objectives of the N119 - New Technology in Physical Education course, comparing it with a typical learning approach at Democritus University of Thrace. Ninety-three (n=93) first-year undergraduate Physical Education students, aged 18 to 20, were assigned to two teaching method groups by a random draw: a flipped instructional (FI) group with 47 students and a typical instructional (TI) group with 46 students. The instructional period, practical exercises (activities), and testing occurred over six consecutive weeks, involving five 90-minute training sessions for the participants. At the beginning and at the end of the experimental procedure, students underwent cognitive assessments (quizzes, exams) as pre- and post-test measurements, respectively. A two-way analysis of variance (ANOVA) with repeated measures was conducted to evaluate the effect of teaching methods and measurements across time on cognitive performance. The data analysis revealed no significant differences between the cognitive performance scores of FI and TI students in this course content. Specifically, the results indicated that both instructional methods had a significant impact on students' cognitive performance, with FI students achieving similar scores to those in the TI teaching approach. These results imply that variations in learning outcomes between formats, as identified in previous literature, may be influenced by additional factors not considered in this study.

Keywords: Cognitive performance; flipped classroom; typical learning; technology; physical education

Introduction

The disparity between classroom practices and higher education training necessitates a transformation of the academic model. This new paradigm involves a transition to hybrid learning, integrating novel tools and methodologies that challenge the traditional teaching approaches that have persisted for decades in universities. This shift aims to enhance the teaching-learning process by offering dynamic and innovative opportunities through active student participation (Hinojo-Lucena, Mingorance-Estrada, Trujillo-Torres, Aznar-Díaz, Cáceres Reche, 2018) ^[1].

In this context, the rise of innovative approaches, tailored to meet the needs of students, has prompted educators to reassess educational practices. The emphasis is shifting from traditional methods to placing students at the forefront, encouraging active participation, nurturing practical thinking, and enhancing digital skills (Cheng et al., 2023) ^[2]. The flipped classroom, a technology-driven model that provides students with direct access to video lectures, slides, and other educational resources on online platforms, has gained increasing visibility and relevance in response to this shift. The flipped classroom model is an educational approach that reverses the traditional sequence of in- and out-of-class activities. In this model, initial instruction, such as the introduction to new knowledge, occurs before the class meeting, while practice and application of knowledge, such as homework problems, are conducted during the class session. Consequently, flipped learning involves completing homework assignments in the classroom setting, with classwork materials distributed online (Aljermawi, Ayasrah, Al-Said, Abualnadi & Alhosani, 2024) ^[3].

The efficacy of the flipped classroom model and its potential benefits for the teaching and learning process have

been extensively explored in a substantial body of research across various subject domains and educational levels (Lo & Hew, 2017) ^[4]. Notably, evaluations have been conducted in humanities (Kong, 2014) ^[5], mathematics (Scott, Green & Etheridge, 2016) ^[6], statistics (Foldnes, 2016) ^[7], science (Baepler, Walker & Driessen, 2014) ^[8], technology (Davies, Dean & Ball, 2013) ^[9], physical education (Hinojo-Lucena et al., 2018) ^[1], and various healthcare fields (Njie-Carr et al., 2017; Mitroka, Harrington & DellaVecchia, 2020; Morton & Colbert-Getz, 2017) ^[10,11].

Research on the flipped instructional model has shown that it can assist teachers in improving the teaching and learning conditions for their students (Hinojo-Lucena et al., 2018; Kostaris, Sergis, Sampson, Giannakos & Pelliccione, 2017) ^[1, 13]. Additionally, the flipped model has been associated with enhanced cognitive learning outcomes (Cheng, Ritzhaupt & Antonenko, 2019; Hinojo-Lucena et al., 2018) ^[14, 1], skill development (Tanner & Scott, 2015) ^[15], and overall student motivation (Hinojo-Lucena et al., 2018; Sahin, Cavlazoglu, & Zeytuncu, 2015) ^[1, 16].

On the contrary, some research has indicated that student learning outcomes in the flipped classroom are not significantly different from those in the traditional classroom (Morton & Colbert-Getz, 2017; Scott et al., 2016) ^[12, 6]. For instance, findings from a business course revealed minimal differences in scores between flipped and non-flipped classrooms taught by the same instructor (Findlay-Thompson & Mombourquette, 2014) ^[17]. Morton & Colbert-Getz (2017) ^[12] discovered that post-graduate medical training conducted in both flipped and traditional instructional models did not result in any significant variation in students' learning outcomes overall. Similarly, a comprehensive study conducted at West Point Academy

suggested that while the flipped classroom might offer short-term benefits, it does not improve learning over time, as evidenced by quiz and exam scores (Setren, Greenberg, Moore & Yankovich, 2019)^[18].

Therefore, the purpose of this study was to evaluate the effectiveness of a flipped learning approach in delivering the objectives of the N119 - New Technology in Physical Education course, comparing it with a typical learning approach at Democritus University of Thrace. The research questions guiding this study were the following:

1. Are there differences in mean cognitive learning scores between the Flipped Instructional (FI) group and the Typical Instructional (TI) group?
2. Do students, on average, report differently on the cognitive learning for the pre-test and post-test measurements?
3. Do the differences in means for the cognitive learning between the FI and the TI groups vary between the pre-test and post-test measurements?

Methods

Participants

In this study, ninety-three ($n=93$) freshmen from the Department of Physical Education and Sport Science at Democritus University of Thrace took part. Their ages ranged from 18 to 20 years ($M=19$, $S.D. =1.03$), with 49 being male (52.7%) and 44 female (47.3%). These students were enrolled in the N119 - New Technologies in Physical Education course during the winter semester of 2021. The students were divided into two teaching method groups by a random draw: the flipped instructional group, consisting of 47 students (24 males and 23 females), and the typical instructional group, comprising 46 students (25 males and 21 females). Before the experimental process began, students were briefed on the research's purpose, the specific experimental group they were assigned to, the teaching methodology, and their responsibilities for participating in the experiment. Each student gave voluntary consent to participate, with the assurance that their involvement would not affect their grades.

Instruments

To evaluate students' cognitive learning outcomes aligned with the objectives of the N119 - New Technology in Physical Education course, a total of four quizzes and a final performance test were developed. A table of specifications was created to illustrate the connections between the identified course content and the levels of learning. In accordance with these specifications, four modules, each comprising 10 items, were crafted, along with a final quiz containing 20 items. All tests were structured as multiple-choice, with each item presenting five options to minimize the possibility of guessing. The test construction followed the linear model, where test scores were determined by summing the number of correct answers, assigning equal weight to each item. This approach ensures a straightforward calculation of scores based on the total number of correct responses across the items.

Procedure

Two instructional models were employed and compared in this study based on learning activities conducted before, during, and after class. The flipped instructional model involved pre-class activities where students were introduced

to new concepts through readings and EDpuzzle videos. In-class sessions began with a review of the previous week's cognitive check, followed by a short lecture and interactive quizzes using web-based responses. If responses were below 90% correct, students engaged in group discussions before responding again. The instructor facilitated class discussions and clarified misconceptions. Approximately 6-10 questions were covered in each class. After class, students submitted a 10-question handout as a self-explanation via the eClass platform by the end of the instructional week.

In the traditional instructional model, pre-class activities involved students completing similar readings to those in the flipped model. In-class sessions began with a review of the previous week's cognitive check, followed by direct instruction on new concepts with a slide show. The video watched by flipped section students during their EDpuzzle activity was shown at the end of the lecture. Instructors occasionally asked questions during lectures, allowing students to raise hands and ask questions. Students took notes using handouts, which could be done by hand or computer. The second-class session each week included a lecture, the video, and a cognitive check. After class, students were required to submit a 10-question handout as self-explanations via the eClass platform by the end of the instructional week.

The instructional period, practical exercises (activities), and tests lasted six consecutive weeks, including five 90-minute instructional sessions. At the beginning and at the end of the experimental procedure, students underwent cognitive assessments (quizzes, exams) as pre- and post-test measurements, respectively.

Statistical analysis

The experimental design in this study was a pre-test/post-test design. Prior to analysis, data were screened for violations of statistical assumptions, and no violations were detected (Green, & Salkind, 2017). A two-way analysis of variance (ANOVA) with repeated measures was conducted to evaluate the effect of teaching methods and measurements across time on cognitive performance. The dependent variable was cognitive learning scores. The within-individuals' factors were teaching method groups with two levels (FI, TI) and time with two levels (pre-test, post-test). Significant differences between the means across time were tested at the 0.05 alpha level. An effect size was computed for each analysis using the eta-squared statistic (η^2) to assess the practical significance of findings. Cohen's guidelines were used to interpret η^2 effect size: 0.01=small, 0.06=medium and 0.14=large (Cohen, 1988).

The hypotheses of this study were:

H01: There will be no statistically significant difference in the mean scores of cognitive performances between the experimental groups (FI and TI).

H02: There will be no statistically significant difference in the mean scores of cognitive performances between the pre- and post-test measurements.

H03: There will be no statistically significant difference in the mean scores of cognitive performances between the experimental groups (FI and TI) in the pre- and post-test measurements.

Results

An independent samples t-test was conducted to evaluate the hypothesis that both experimental groups (FI and TI) would not differ significantly on measure of cognitive performance at pre-test. Indeed, there were no significant initial differences between the two method groups in the mean cognitive learning scores, $t(91) = -1.14, p = .256$.

Two-way analysis of variance (ANOVA) with repeated measures was conducted to evaluate the Hypotheses (H1, H2 and H3). As demonstrated in what follows, the H2 hypothesis was not supported.

A significant main effect was noted for Time, $F(1, 91)=4399.92, p<0.001$, partial $\eta^2=0.980$, while the Teaching

methods x Time interaction effect was not significant, $F(1, 91)=0.217, p=0.643$, partial $\eta^2=0.002$. The univariate test associated with the Teaching method group’s main effect was also not significant, $F(1, 91)=2.6, p=0.110$, partial $\eta^2=0.028$.

Pairwise comparisons using t-test with a Bonferroni adjustment were used to analyzing the main effect of Time. The results revealed significant mean differences in cognitive performance between pre-test and post-test ($MD=-21.2, p<0.001$) in both experimental groups (FI, TI). As shown in Figure 1, the post-test cognitive scores were remarkably higher than pre-test cognitive scores for both experimental groups.

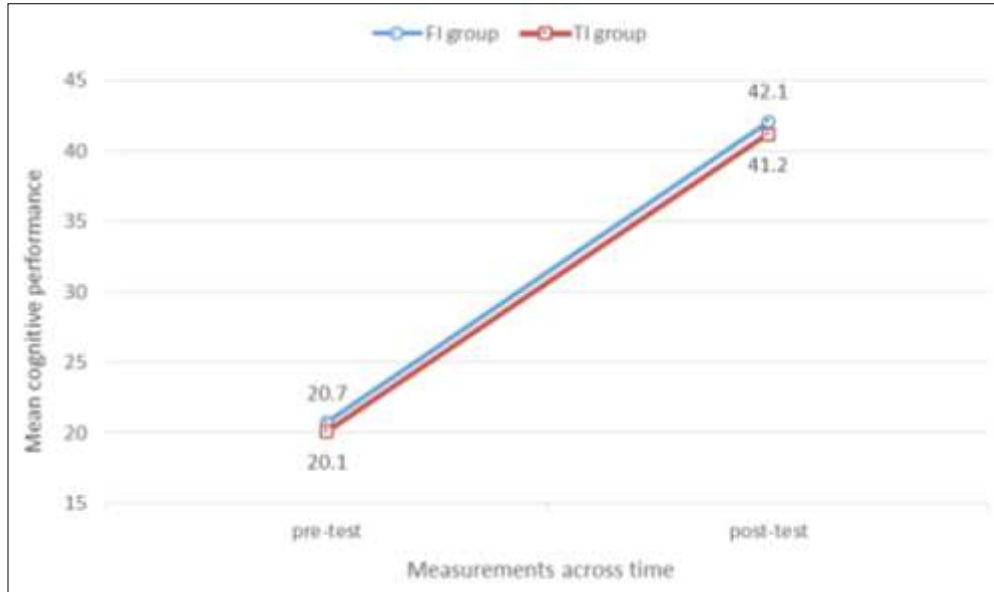


Fig 1: Mean scores of the experimental groups (FI and TI) in cognitive learning.

Discussion

An expanding body of research is centered on the design of flipped classrooms, which combines e-learning with traditional face-to-face teaching. Despite a growing body of literature exploring the integration of these modalities (Zacharis, 2015), there is a limited focus in research on the specific characteristics of these blends and how varying blends might impact students' learning performance differently. Therefore, the purpose of this study was to contribute to the blending learning literature by evaluate the effectiveness of a flipped learning approach in delivering the objectives of the N119 - New Technology in Physical Education course, comparing it with a typical learning approach at Democritus University of Thrace. To fulfill this objective, precise questions were formulated, investigated, and the study's findings regarding these questions are elaborated upon below.

The research question aimed to investigate potential disparities in cognitive learning means between the FI and TI groups and between pre-test and post-test measurements. The study's data strive to uphold the hypothesis that there will be no statistically significant difference in mean scores of cognitive performances between the experimental groups (FI and TI) in both pre-test and post-test measurements.

The data analysis revealed no significant differences between the cognitive performance scores of FI and TI students in the N119 - New Technology in Physical Education course objectives. Additionally, both groups

demonstrated improvement in their cognitive learning within this course content. In other words, the results indicated that both instructional methods had a significant impact on students' cognitive performance, with FI students achieving similar scores to those in the TI teaching approach. These results imply that variations in learning outcomes between formats, as identified in previous literature, may be influenced by additional factors not considered in this study.

The similarity in scores between classes could be attributed to the lack of discernible instructional benefits between the models. Both classes received identical content in the same sequence, aiming to isolate differences related to effortful retrieval and peer interaction in the flipped classroom. The results suggest that these aspects may not be the factors contributing to enhanced learning outcomes, as students received nearly identical content with no difference in learning outcomes. This underscores the importance of content quality and engagement levels in instructional design, emphasizing the need for intentional choices informed by evidence for instructors planning to use either flipped or traditional instructional formats (Peterson, 2016). The findings of this study contribute to the existing body of literature, indicating the need for additional research to pinpoint the specific features or learning activities within the flipped classroom that may contribute to enhanced learning outcomes compared to more traditional classroom settings.

Conclusions

There has been a recent emphasis on incorporating more active learning opportunities in classrooms, driven by concerns that lecture-based instruction is passive and may not adequately support learners in encoding and retaining new knowledge (Hinojo-Lucena et al., 2018) ^[1]. The push for active and engaging learning environments has led to an increased adoption of the flipped classroom (Cheng et al., 2023; O'Flaherty & Phillips, 2015) ^[2]. However, research comparing the flipped and traditional formats has yet to provide definitive evidence on which design elements (e.g., voice-over slides, interactive group work) are most beneficial for engaging students and improving learning outcomes. If the suggested research indicates comparable learning outcomes in both instructional formats, it suggests that the inversion of instruction and knowledge application may be less critical than ensuring students are actively engaged in the learning activities.

References

- Hinojo-Lucena FJ, Mingorance-Estrada AC, Trujillo-Torres JM, Aznar-Díaz I, Cáceres Reche MP. Incidence of the Flipped Classroom in the Physical Education Students' Academic Performance in University Contexts. *Sustainability*,2018;10(5):1334.
- Cheng C, Ahmad SF, Irshad M, Alsanie G, Khan Y, Ahmad AYAB, Aleemi AR. Impact of Green Process Innovation and Productivity on Sustainability: The Moderating Role of Environmental Awareness. *Sustainability*,2023;15(17):12945.
- Aljermawi H, Ayasrah F, Al-Said K, Abualnadi H, Alhosani Y. The effect of using flipped learning on student achievement and measuring their attitudes towards learning through it during the corona pandemic period. *International Journal of Data and Network Science*,2024;8(1):243-254.
- Lo CK, Hew KF. A critical review of flipped classroom challenges in K-12 education: Possible solutions and recommendations for future research. *Research and Practice in Technology Enhanced Learning*,2017;12(1):4.
- Kong SC. Developing information literacy and critical thinking skills through domain knowledge learning in digital classrooms: An experience of practicing flipped classroom strategy. *Computers & Education*,2014;78:160-173.
- Scott CE, Green LE, Etheridge DL. A comparison between flipped and lecture-based instruction in the calculus classroom. *Journal of Applied Research in Higher Education*,2016;8(2):252-264.
- Foldnes N. The flipped classroom and cooperative learning: Evidence from a randomised experiment. *Active Learning in Higher Education*,2016;17(1):39-49.
- Baepler P, Walker JD, Driessen M. It's not about seat time: Blending, flipping, and efficiency in active learning classrooms. *Computers & Education*,2014;78:227-236.
- Davies RS, Dean DL, Ball N. Flipping the classroom and instructional technology integration in a college-level information systems spreadsheet course. *Educational Technology Research and Development*,2013;61(4):563-580.
- Njie-Carr VP, Ludeman E, Lee MC, Dordunoo D, Trocky NM, Jenkins LS. An integrative review of flipped classroom teaching models in nursing education. *Journal of Professional Nursing*, 2017;33(2):133-144.
- Mitroka JG, Harrington C, DellaVecchia MJ. A multiyear comparison of flipped-vs. lecture-based teaching on student success in a pharmaceutical science class. *Currents in Pharmacy Teaching and Learning*,2020;12(1):84-87.
- Morton DA, Colbert-Getz JM. Measuring the impact of the flipped anatomy classroom: The importance of categorizing an assessment by Bloom's taxonomy. *Anatomical Sciences Education*,2017;10(2):170-175.
- Kostaris C, Sergis S, Sampson DG, Giannakos MN, Pelliccione L. Investigating the potential of the flipped classroom model in K-12 ICT teaching and Learning: An action research study. *Journal of Educational Technology & Society*,2017;20(1):261-273.
- Cheng L, Ritzhaupt AD, Antonenko P. Effects of the flipped classroom instructional strategy on students' learning outcomes: A meta-analysis. *Educational Technology Research and Development*,2019;67(4):793-824.
- Tanner M, Scott E. A flipped classroom approach to teaching systems analysis, design and implementation. *Journal of Information Technology Education: Research*,2015;14:219-241.
- Sahin A, Cavlazoglu B, Zeytuncu YE. Flipping a college calculus course: A case study. *Educational Technology & Society*,2015;18(3):142-152.
- Findlay-Thompson S, Mombourquette P. Evaluation of a flipped classroom in an undergraduate business course. *Business Education & Accreditation*,2014;6(1):63-71.
- Setren, E., Greenberg, K., Moore, O., & Yankovich, M. (2019). Effects of the flipped classroom: Evidence from a randomized trial. *School Effectiveness and Inequality Initiative*,2019:363-387.
- Green SB., Salkind NJ. *Using SPSS for Windows and Macintosh: Analyzing and understanding data* (8th ed.). Upper Saddle River, NJ: Pearson, 2017.
- Cohen J. *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum, 1988.
- Zacharis NZ. A multivariate approach to predicting student outcomes in web-enabled blended learning courses. *The Internet and Higher Education*,2015;27:44-53.
- Peterson DJ. The flipped classroom improves student achievement and course satisfaction in a statistics course: A quasi-experimental study. *Teaching of Psychology*,2016;43(1):10-15.
- O'Flaherty J, Phillips C. The use of flipped classrooms in higher education: A scoping review. *The Internet and Higher Education*,2015;25:85-95.