

EFFECTIVENESS OF THE FLIPPED CLASSROOM METHODOLOGY IN THE PERFORMANCE OF HIGHER EDUCATION STUDENTS - SYSTEMATIC REVIEW WITH META-ANALYSIS

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Abstract

Introduction: The methodology Flipped Classroom (FC) consists in individual activities that the student has to do at home through the use of technologies which help the student to prepare for class, and during classes, activities are performed as more dynamic classes centered on the student. Through the years, the success has reached the maximum levels of performance and satisfaction in the teaching sessions in different areas of education compared to the classical methods, and there are no conclusive and considerable studies that compile and analyze this information succinctly.

Objective: To analyze experimental and quasi-experimental studies that evaluate the methodology database in FC in performance and student satisfaction in comparison with the expository methodology.

Methodology: This article is a systematic review that analyzes the RCT and Quasi - experimental studies selected with the methodology FC, which measures the efficacy through the results achieved in the realization and evaluation of the students. These articles were found in EBSCOhost and PubMed.

Results: We selected 41 articles, that fulfilled all inclusion criteria established by the authors, for the accomplishment of this systematic review. The results of our meta-analysis, both RCTs and quasi-experimental studies, point to a better effectiveness of the FC methodology compared to the expository methodology in academic performance. However, there is a heterogeneity in planned and developed activities during class, which means that our conclusions can't be generalized. The poor methodological quality of the included studies, especially quasi-experimental studies, does not allow our conclusions about efficacy to be vigorous. Nevertheless, based on these first promising data, it seems to us that this methodology offers learning opportunities that aren't possible in a classroom based on lectures and subject matter exposition.

Conclusion: Although the articles selected have poor methodological quality, and is necessary more rigorous investigations on this methodology, we believe that the FC methodology could revolutionize teaching methods and replace traditional teaching, which is so deeply rooted in today's society and doesn't seems to favor the achievement of transversal competences.

Keywords: Flipped classroom, expository methodology, performance, higher education.

1 INTRODUCTION

Over the past decade, alerts for reform in education in general and in the health sciences in particular have intensified [1]. The increase not only in the total volume of information, but also in the ease of access requires the role of universities and other educational institutions to be rethought. The next generation of students needs to develop the ability to discriminate a large amount of information and extract and synthesize the knowledge needed for clinical decision making. Vocational education has not kept pace with some of the challenges of the 21st century, largely due to fragmentation, outdated and static curricula that form professionals ill-prepared for the needs of the population[1].

We are facing an era in which education systems place great emphasis on making the most of time during various curriculum activities. In health science education there is evidence that traditional preclinical education has become too dependent on lectures and other passive didactic models and that these methods are less effective in equipping students with reflective knowledge and skills to solve problems in clinical contexts. Some authors have proposed the application of new teaching approaches, such as the flipped classroom (FC), to improve preclinical education [2], [3].

This innovative training approach aims to place the student at the center of the educational process. The concept has had several designations over the past few years, such as flip teaching, flip the

classroom, flipped classroom, flipped learning. All designations have in common the same verb form as the verb to flip. In a simplified way, the use of the expression flip means, in this context, to mean a turning point, which consists in doing at home the work that normally occurs in the classroom and doing in it the work that is supposed to be done at home. Since 2006, two US teachers, Aaron Sams and Jonathann Bergmann, have played a major role in promoting the flipped classroom and have progressively introduced this approach into the world of education.

Generally speaking, the flipped classroom consists of the following elements: (1) students are seen as an active part of their learning process; (2) technologies act as a facilitating element in the self-directed learning process; (3) video viewing should take place a priori to class time; (4) are assigned to the group of students problems based on real situations; (5) class time is allocated to work, and the teacher should act as a guide, providing instruction and guiding the “path” in solving the problem, rather than the traditional expository method in which the teacher uses this same time to expose the subject, with a student playing a passive role [4].

As we have seen, this approach presupposes an autonomous student preparation out of class, so that time spent in the classroom is monetized with specific types of collaborative active learning activities, such as problem-based learning (PBL), team-based learning (TBL), case-based learning (BBL), POGIL (Process Oriented Guided Inquiry Learning) activities, among others [3], [6].

Although this teaching method has been showing promising levels of student success and satisfaction in different areas of education compared to traditional methods [6], there is as yet no study to compile and analyze this information. Thus, the objective of this paper is to review and analyze experimental and quasi-experimental studies that evaluate the effectiveness of the FC methodology in the performance of higher education students compared to the expository methodology. The guiding question is: “Is the FC methodology more effective than the expository methodology in improving the academic performance of higher education students?”

2 METHODOLOGY

This article is a systematic review that was based on Cochrane's guideline methodology.

Inclusion criteria

In order to obtain the articles for this study, several inclusion criteria were defined, such as: the language (Portuguese, English, Spanish and French), the type of study (Randomized Controlled Trial (Randomized Trials) RCT) and quasi-experimental studies (QE), population (higher education students), intervention (flipped classroom), outcome measures (academic performance), retreat time and type of publication (full papers published in journals). Then, we explicitly explain and justify the inclusion criteria, which are related to the research question, as well as to the theoretical foundation previously performed.

Selection of databases

Education specific databases were selected: Education Research Complete (ERC) and Academic Search Complete (ASC). The PubMed database was also used, as this methodology is widely used in the health sciences.

Search Expression and Search Strategy

The following search expression was applied to all databases:

“Flip” AND (learn OR teach OR class OR course OR lecture OR instruction) AND (attain OR achieve OR effective goal GO knowledge OR skill OR effect OR outcome OR feedback) AND (graduate OR high) AND (school OR education) AND (university OR institute OR college).

The search was made in January 2018.

Data collection and analysis

Study Selection

The selection of the various articles was made based on the inclusion criteria mentioned above. Initially, all existing duplicate articles were automatically and manually deleted. As well as those that did not match the pre-established languages. In the next phase, all six reviewers individually and independently read the titles and abstracts of the articles and filled out a table to exclude those who did not meet the inclusion criteria. Articles classified as “in doubt” were discussed at a consensus meeting with the principal investigator and duly included in the “include” or “exclude” category, whether or not they met

the criteria. Then, the full text of the selected articles was read, again, by all reviewers, individually, in order to verify their consistency with the inclusion criteria. A new consensus meeting was held to discuss possible disagreements among reviewers and to select the final set of articles included in the study.

Risk of Bias

To minimize possible bias in the results obtained, the selected articles were submitted to an evaluation regarding their methodological quality. This was held individually by the six reviewers and at the end a new consensus meeting was held. The methodological quality analysis criteria of the articles included in the systematic review were based on the Cochrane Collaboration criteria for the development of systematic intervention reviews, as they were the most used in systematic intervention reviews and were as follows [7]: 1. Randomization of the distribution, 2. Allocation concealment, 3. Blind subjects and professionals, 4. Blind evaluators, 5. Incomplete data, 6. Selective recording of results.

For quasi-experimental studies the Cochrane criteria were also used knowing that the first two criteria would be high risk in all included studies.

Data Extraction

Finally, from each selected study were extracted and recorded in a table, the country of study development, the sample characterization, study design, study duration, description of experimental and control methodology, main variables under study, collection instruments used and results obtained. Data extraction was performed individually and independently by six reviewers. Subsequently, in a consensus meeting, the reviewers' opinions were discussed and a final consensus table was prepared, with the approval of the principal investigator.

Statistical analysis

Data from the included studies were released into *comprehensive meta-analysis*® software to test heterogeneity and the meta-analysis.

3 RESULTS

The following results represent the methodology used. Figure 1 represents the flowchart of article selection.

3.1 Search result

The initial research conducted identified 898 results. 61 duplicates were eliminated, leaving a total of 837 articles. After reading titles and abstract, 780 were deleted, leaving 57 articles with potential to be included in the review. The full text of the 57 selected articles were obtained and the inclusion criteria for reading the full texts were applied. 16 studies that did not meet the inclusion criteria were excluded. After applying these criteria, there were 41 articles [8]–[48] that were included in the systematic review. Of these, only 28 present sufficient data to perform the meta-analysis.

3.2 General features of the included studies

In Table 1 (Follow the link - Table 1) we present a summary of the general characteristics of the studies included in the systematic review.

3.2.1 Description of experimental and control methodologies

In four studies, the authors did not specify how the FC methodology was applied to the experimental group, but only stated that the FC methodology was used. In the experimental methodology, the main activities requested before class were video viewing, content reading in PowerPoint and reading supporting texts. During the classes, the activities used were individual or group tests to check the knowledge acquired before the classes, small group work, discussion of questions, PBL, TBL, POGIL Activities and laboratory activities.

Regarding the control groups, some authors were not specific as to the methodology used referring only that the traditional expository method was used.

In four selected studies, activities such as group problem solving and case activities were added to the traditional method. One study states that the classes were held in the laboratory because they have a practical component.

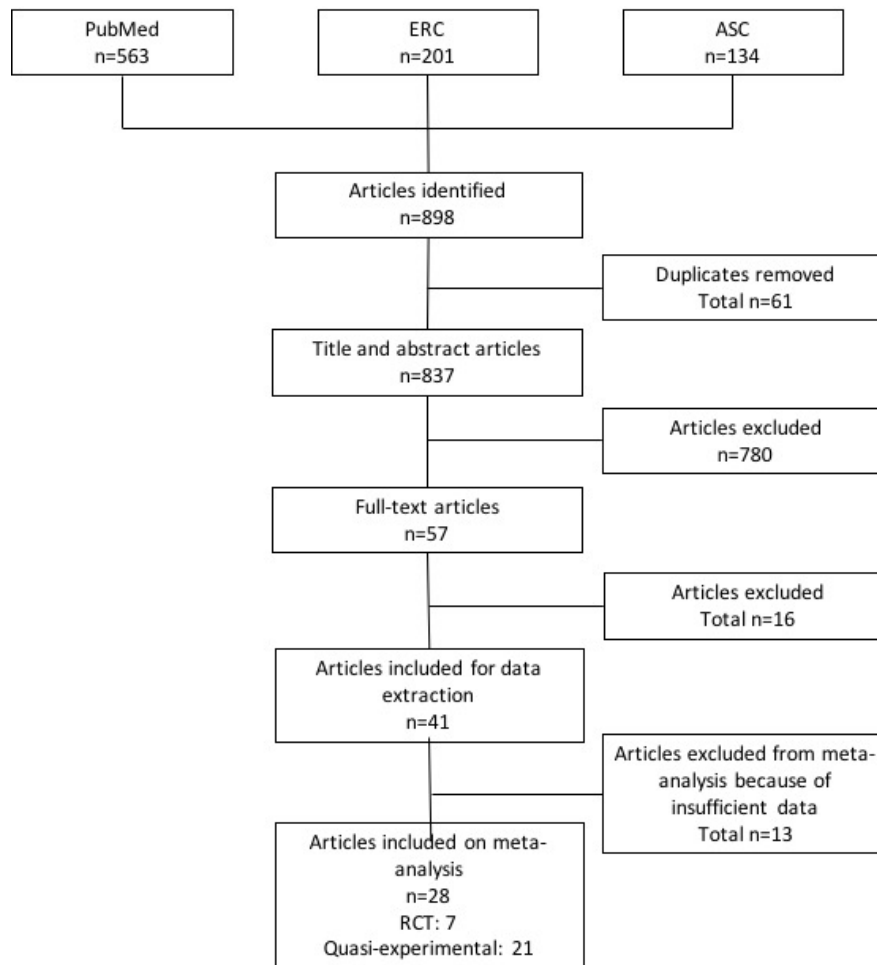


Figure 1. Flowchart.

3.3 Risk of bias

All articles selected for this study have a high risk of bias regarding the part of participants being blind, since all students can understand which is the traditional method and which is the flipped teaching method. Of the 41 articles selected, eight are RCT and 33 are quasi-experimental methodology.

Regarding RCTs, six have a low risk of sample randomization, while two are uncertain. None of the RCTs present high risk in randomization. In concealment of allocation, two RCTs have a low risk of bias, 4 are uncertain and two have a high risk of bias. Regarding the parameter that evaluates if the evaluators are blind, two articles have a low risk, four are not explicit, being considered as uncertain and two have a high risk of bias. All RCTs present a low risk in incomplete outcome and selective registration parameters.

From the quasi-experimental study group, all articles present a high risk of bias regarding the way samples were randomized and their allocation was hidden. Two of these articles have a low risk of bias compared to the evaluators being blind; in 15 articles this risk of bias is uncertain. The remaining 16 have a high risk bias. Regarding the description of the data that led to the final outcome, corresponding to the parameter of incomplete results, only five articles have a high risk of bias and for one article this description is insufficient to draw conclusions, being considered as uncertain, while the remaining 27 present a low risk of bias. Finally, in the record of events and study results, only five articles have a high risk of bias, and the remaining 28 have a low risk of bias.

3.4 Results on outcome measures

Regarding the results obtained, eight studies showed that there were no differences in academic performance between the two groups [10], [17]–[19], [27], [29], [32]. Four studies [10], [12], [14], [16] obtained better results in the control group, with significant differences and one without statistically

significant differences [11]. In the remaining 28 studies, the experimental group had better results with statistically significant differences compared to the control group.

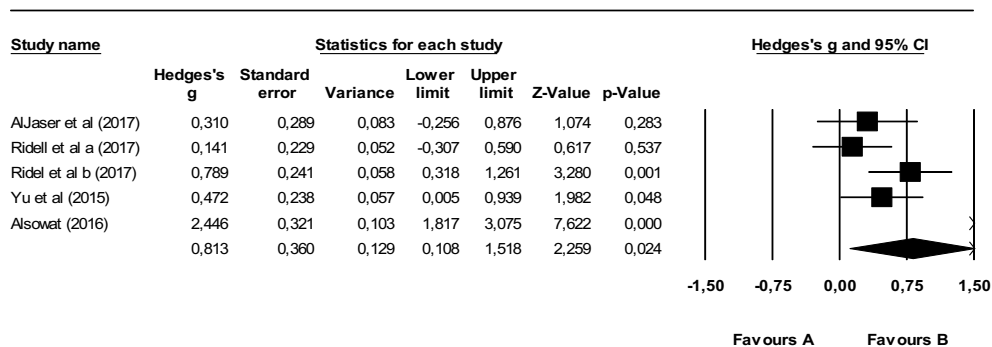
3.4.1 Meta-analysis of FC effect on academic performance

To analyze the effect of FC on academic performance, data (mean and standard deviation) were extracted from the results in the performance measures of the included studies, which were later released in the comprehensive meta-analysis ® software to test heterogeneity and meta-analyze. Of the 8 RCTs, only data from 7 studies were extracted and from 33 quasi-experimental studies only data from 21 were extracted, because the results were not published or were published in graphical form only.

RCT with comparison of two groups (Intervention vs Control) and with Pre and Post test

The 4 studies plotted in the forest plot (Graph 1) refer to comparisons of experimental group and control group in two evaluation moments (base line / post treatment).

Meta-analysis shows significant benefit, Hedges's G meta-analytic measure ($g = 0.813$; 95% CI: 0.108-1.518; $z = 2.259$, $p = 0.024$) and respective confidence interval (diamond ends) to the right of vertical line 0, thus suggesting a statistically significant effect of the intervention, with the effect dimension being high.

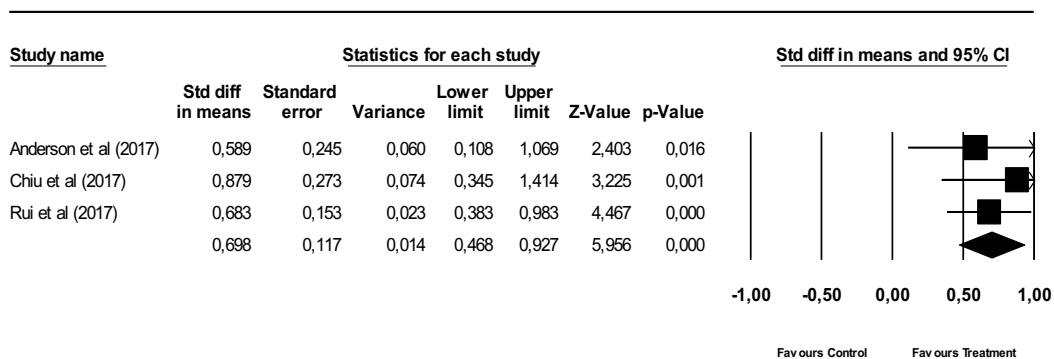


Meta Analysis

Graph 1. Forest plot of comparisons of experimental group and control group in two evaluation moments.

RCT with comparison of two groups (Intervention vs Control) with Post Test only

We can see from graph 2 that the results are more favorable in the experimental group, thus suggesting a statistically significant benefit from the intervention.

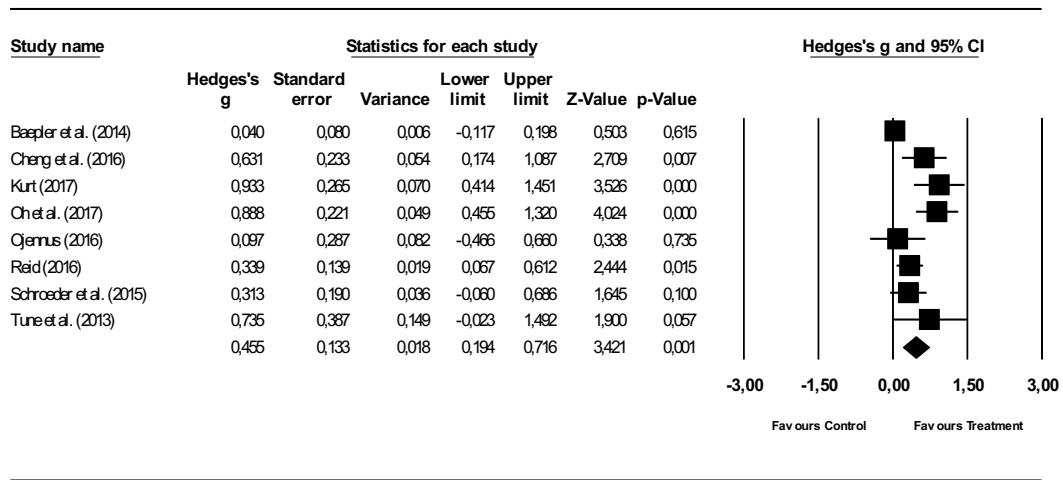


Meta Analysis

Graph 2. Forest plot of comparisons of experimental group and control group with post-test only.

Quasi-experimental studies comparing two groups (same class) with post-test only

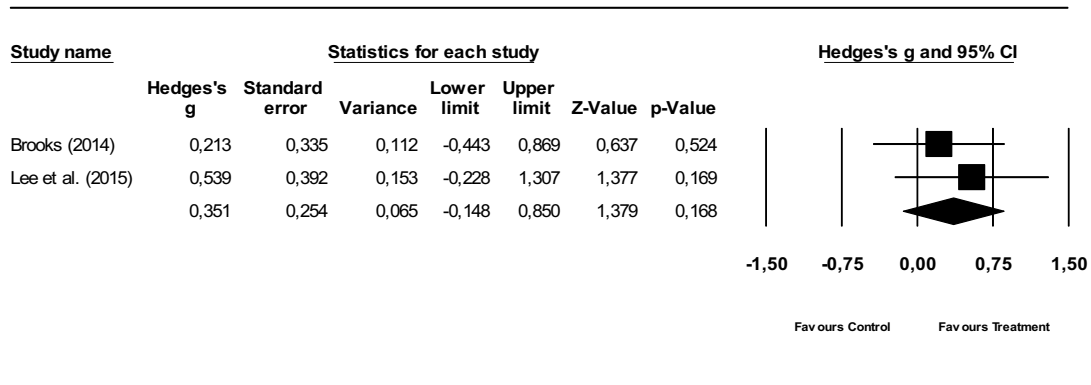
In graph 3, we observed that the event is more likely to occur in the experimental group.



Graph 3. Forest Plot of quasi-experimental studies comparing two groups (same class) with post test only.

Quasi-experimental studies comparing two groups (same class) pre and post test

As we can see from the graph 4 in these studies, none of the results are to the right of the vertical line, so the effect is considered null.

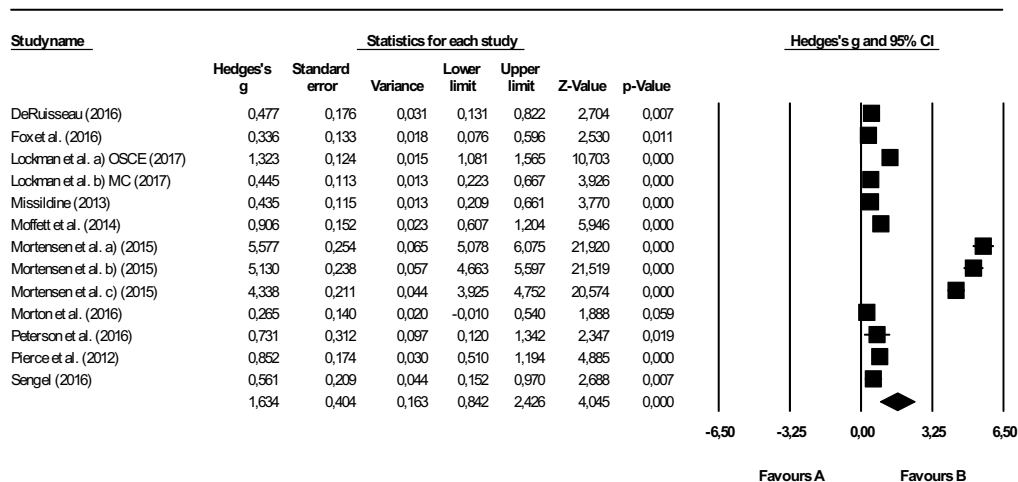


Meta Analysis

Graph 4. Forest plot of quasi-experimental studies comparing two groups (same class) pre and post test.

Quasi-experimental studies comparing two groups (different years) with post-test only

In this meta-analysis, as we can see in the graph 5, the magnitude of the Hedges Analytical Goal g effect is very high and significant, being favorable to the group in which there was intervention.



Meta Analysis

Graph 5. Forest plot of quasi-experimental studies comparing two groups (different years) with post-test only.

4 CONCLUSIONS

This review allowed us to observe that studies on the FC in higher education present a multiplicity of application areas, being a methodology that can be applied in different contexts. However, the most studied area was health, especially medicine.

Although the results of our meta-analysis, both in the RCT and quasi-experimental studies, point to a greater effectiveness of the CF methodology compared to the expository methodology in academic performance, there is a heterogeneity in planned and developed activities during the classes, which means that our conclusions cannot be generalized. On the other hand, the low methodological quality of the included studies, especially quasi-experimental studies, does not allow us to make our conclusions about efficacy robust.

The fact that each teacher has their own FC approach does not allow us to generalize the results obtained. The courses involved in the studies are different, as are the curricular units taught and their themes. Although there has been an improvement and a positive evolution in the studies in recent years on this subject, the relatively recent and innovative FC methodology still lacks methodological quality RCT articles proving its effectiveness, and further studies of this type are needed, standardizing the characteristics of the applied methodology, creating methodology application guidelines for these studies.

Nevertheless, based on these promising early data, it seems to us that this methodology offers learning opportunities that are not possible in a lecture-based classroom. It would be in the interest of future research to also evaluate both short and long term results, since one of the main limitations is the lack of information on long term results.

It should be noted that although not our object of study it was found that in most studies students showed a higher degree of satisfaction and feel more confident to face the challenges in professional life with this methodology. Since it is an important outcome measure, future research should take students' opinions / satisfaction into account using valid measures.

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