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Evaluating the Effectiveness of the Flipped Classroom Approach in Enhancing Students' Academic Achievement and Fostering Higher-Order Critical Thinking Skills

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Abstract

In comparison to traditional instruction, this study assessed how well the flipped classroom (FC) approach fosters higher-order critical thinking skills and improves students' academic achievement. Sixty students were split into experimental and control groups using a quasi-experimental design. While the control group listened to traditional lectures, the experimental group used pre-class multimedia materials and took part in interactive, problem-solving exercises during class. Using achievement tests that were in line with Bloom's taxonomy, academic achievement was evaluated at the knowledge, comprehension, and application levels. The findings showed no discernible difference in knowledge level, but students in the FC group performed noticeably better than their peers in terms of understanding and application as well as overall achievement. These results imply that although traditional instruction is still useful for fact recall, the flipped model has a greater influence on encouraging critical thinking, deeper comprehension, and knowledge application. The study suggests using flipped strategies, especially in subjects where understanding and application are prioritized.

Introduction

The classroom's function is changed from passive information delivery to dynamic, learner-centered engagement as a result of this inversion, which affects when and how students interact with the material (Prieto et al., 2021). The flipped classroom model provides a rich environment for pedagogical innovation as educational paradigms change to better prepare students for difficult, contemporary problems that call for critical thinking, flexibility, and independence. Research over the last ten years indicates that FC can raise academic performance. Systematic reviews and meta-analyses have generally found positive outcomes in higher education, especially in STEM domains (van Alten et al., 2019), although effect sizes vary by discipline and context. However, methodological flaws and implementation variations warn against making too many generalizations (Buhl-Wiggers, la Cour, & Kjaergaard, 2023).

At the same time, it is becoming more widely acknowledged that analysis, evaluation required skills (Facione, 1990). Rich in-class activities and organized preparation are

two ways that flipped classrooms promote deeper engagement. By specifically focusing on Facione's specified skills, recent research shows that FC can greatly improve aspects of critical thinking in business education (Ma, 2023).

However, there are still significant questions. How much of an impact does FC have on academic performance? How consistently, across levels and disciplines, does it promote critical thinking? Which FC designs work best to maximize these results, and which issues—like student resistance—need to be addressed (Buhl-Wiggers et al., 2023)? In order to shed light on the impact of FC on academic achievement, this study will incorporate recent research and provide evidence-based suggestions for future study and implementation.

Literature Review

Flipped Classroom and Academic Achievement

In general, FC improves student performance, according to thorough reviews. Significant improvements across disciplines were reported by Akçayır and Akçayır (2018). While pointing out contextual variability in effect size, Strelan et al. (2020) supported these findings. According to these reviews, learner readiness, course discipline, and implementation fidelity all affect how effective FC is.

A randomized controlled trial was carried out in an undergraduate economics course by Buhl-Wiggers et al. (2023). The study discovered that while FC did not produce a statistically significant improvement in raw academic outcomes, it did have a significant positive impact when student participation was taken into consideration as a mediating variable, acknowledging that some students opposed the new model. This highlights how crucial it is to address learner engagement and readiness in addition to pedagogical design. FC has continuously shown notable advantages in technical and lab-based fields like engineering and physics. In their analysis of two-year lab courses, Gómez-Tejedor et al. (2020) found that FC significantly improved academic performance when compared to traditional instruction. The validity of the model was confirmed across quantitative subjects by Karjanto and Acelajado's (2022) investigation of flipped college algebra, which showed noticeably higher cognitive gains.

When compared to traditional lectures, Chen, Wang, Kinshuk, and Chen (2014) discovered that flipped classrooms in engineering education enhanced students' grades

and conceptual understanding. According to Gilboy, Heinerichs, and Pazzaglia (2015), students' exam scores in health sciences courses that used the flipped model significantly improved. According to Lo and Hew's (2017) meta-analysis, which included 55 empirical studies, FC better than lecture-based settings, demonstrating greater gains in application and retention of knowledge. Increased student involvement and the availability of review materials that facilitate mastery learning are frequently cited as the reasons for this improvement (Thai, De Wever, & Valcke, 2017).

Flipped Classroom and Critical Thinking

A key component of educational outcomes is critical thinking, which is necessary for adaptive learning and problem-solving (Facione, 1990). The structure of FC—absorbing material before class and discussing, reflecting, aligns with pedagogical approaches that are known to encourage these kinds of cognitive processes.

In a business administration setting, Ma's (2023) experimental study assessed critical thinking along six Facione-defined dimensions. He discovered through a quasi-experimental design that, in contrast to traditional instruction, FC greatly improved students' critical thinking, indicating that, when pedagogically structured, flipping facilitates deeper cognitive engagement. Furthermore, systematic literature reviews like Rahmatika, Hanapi, and Jendriadi (2024) support the beneficial effects of FC on critical thinking across disciplines and provide evidence that FC is a better way to scaffold reasoning, analysis, and decision-making than lecture-only formats.

Mechanisms: Boost HOTs and Critical Thinking

By moving the delivery of passive content to pre-class time, FC exemplifies active learning by allowing in-class time for reflective, cooperative, and investigative activities (Prieto et al., 2021). Research from a variety of STEM disciplines demonstrates that active learning techniques greatly improve conceptual understanding more than traditional lectures (Freeman et al., 2014; Hake, 1998). Given its compatibility with active learning, FC may provide comparable cognitive advantages.

Students can process information at their own pace when given access to it before class, which lessens cognitive overload. This foundation can then be expanded upon in class through discussion and problem-solving, which maximizes learning

through retrieval practice and reinforcement—two crucial techniques for developing critical thinking and cognitive retention. FC gives students more responsibility for getting ready for class. Self-control, planning, and metacognitive reflection—skills inextricably linked to critical thinking—are fostered by this autonomy (Ma, 2023). Giving students more autonomy promotes internal motivation and deeper engagement, which improves performance and higher-order thinking.

Pedagogical Transformation

One of the most revolutionary developments in education in recent decades is the flipped classroom. It shifts the delivery of knowledge from in-class time to outside time, such as through recorded lectures, online resources, or multimedia, while reserving in-class time for problem-solving, teamwork (Bishop & Verleger, 2013). With its emphasis on active participation, peer collaboration, and application-based learning, this reorganization is consistent with constructivist learning theories (O'Flaherty & Phillips, 2015). According to flipped classroom pioneers Bergmann and Sams (2012), the method gives teachers the chance to tailor instruction and gives students the chance to become more independent learners.

Challenges and Moderators

According to Buhl-Wiggers et al. (2023), resistance was a major deterrent because many students were not used to preparing on their own, which would have slowed achievement gains unless participation was specifically addressed. According to meta-analyses, FC is most effective when students are familiar with the model and given time management and accountability support (O'Flaherty & Phillips, 2015). Not every FC implementation is created equal. Simply switching lectures to video is not enough, according to Bergmann & Sams (2012); FC calls for rearranging class time to encourage participation and introspection. Research that uses strong design models (such as scaffolding, guided inquiry, and real-world problem tasks) produces better results than studies that simply flip the delivery format (Prieto et al., 2021).

Although the fields of math, science, and business exhibit encouraging FC results, care must be taken when extrapolating to the humanities, languages, or foundational courses. Assessment types, student preparedness, and course content may all interact differently with FC. There needs to be more interdisciplinary research. The flipped classroom approach is not always successful, despite its advantages.

According to certain research, students' preparation and motivation outside of the classroom play a major role in its success. In-class learning activities become less effective if students neglect their pre-class assignments (Jensen, Kummer, & Godoy, 2015). Additionally, creating high-quality materials for the flipped classroom requires a lot of teacher preparation, which could restrict scalability in situations with limited resources (Zainuddin & Halili, 2016).

Furthermore, there is conflicting data about how it affects critical thinking. Although numerous studies show favorable results, some contend that improvements in critical thinking rely on the organization of class time (Betihavas, Bridgman, Kornhaber, & Cross, 2016). For instance, in flipped classrooms, teacher-led discussions or rote worksheets might not be all that different from traditional approaches in terms of encouraging higher-order skills. Effective instructional design is therefore still essential.

Cross-Cultural Perspectives

It may differ depending on the discipline and culture. Some students initially oppose flipped models because of the greater demand for autonomy in Asian contexts, where teacher-centered pedagogy is common (Chen, Liu, & Martinelli, 2017). However, when properly executed, flipped classrooms can promote greater engagement, particularly in collectivist cultures where teamwork is highly regarded (Hao, 2016). Disparities in discipline also influence results. In STEM fields, where problem-solving and real-world applications are paramount, flipped classrooms are especially effective (Låg & Saele, 2019). The advantages are more complex in the humanities since flipped approaches might overlap with already-used discussion-based techniques. Flipped approaches, however, have been shown to boost interest and promote more in-depth textual analysis even in literature and history (Baepler, Walker, & Driessen, 2014).

Methodology

In order to compare the efficacy of the flipped classroom approach with the conventional learning method, this study used a quasi-experimental research design. There were 60 students in the sample, split equally between 30 students in the experimental group and another 30 students in the control group. The experimental group received instruction using the flipped classroom model, in which discussions,

problem-solving, and higher-order activities took place during class time while students watched lectures and studied materials that had been pre-recorded. On the other hand, conventional lecture-based instruction was given to the control group. Together with overall performance, academic achievement was assessed in three cognitive domains: knowledge, comprehension, and application. Following the lesson, both groups took achievement tests that were in line with Bloom's taxonomy. To ascertain mean differences between groups, data were analyzed using independent sample t-tests, with significance set at the.05 level.

Data Analysis and Results

Table 1: ***Evaluating the Effectiveness of the Flipped Classroom Approach and Traditional Learning Method in Enhancing Students' Academic Achievement at Knowledge Level***

Group	N	Mean Value	Standard deviation	t-value	p-value
Experimental	30	13.43	2.67	-1.60	.115
Control	30	14.77	3.69		

There was no statistically significant difference between the experimental and control groups in terms of students' academic achievement at the knowledge level, according to the results shown in Table 1. With flipped classroom instruction, the experimental group received a mean score of 13.43 (SD = 2.67), while the control group received traditional instruction and received a slightly higher mean score of 14.77 (SD = 3.69). The calculated t(58) = -1.60 and p value of.115, both of which are higher than the significance level of.05, show that there is no statistically significant difference in the mean scores of the two groups. These findings imply that the flipped classroom strategy did not substantially outperform the conventional teaching approach at the knowledge level.

Table 2: ***Evaluating the Effectiveness of the Flipped Classroom Approach and Traditional Learning Method in Enhancing Students' Academic Achievement at Comprehension Level***

Group	N	Mean Value	Standard deviation	t-value	p-value
Experimental	30	12.30	2.34	8.82	.000
Control	30	6.67	2.60		

The experimental and control groups' academic performance at the comprehension level differed significantly, according to the results shown in Table 2. The control group, which was instructed using conventional methods, received a mean score of 6.67 (SD = 2.60), whereas the experimental group, which was instructed using the flipped classroom approach, received a mean score of 12.30 (SD = 2.34). This difference is statistically significant, as indicated by the computed t(58) = 8.82 and p value of.000 (p <.05). These results show that the flipped classroom strategy significantly outperformed traditional instruction in raising students' academic achievement at the comprehension level.

Table 3: ***Evaluating the Effectiveness of the Flipped Classroom Approach and Traditional Learning Method in Enhancing Students' Academic Achievement at Application Level***

Group	N	Mean Value	Standard deviation	t-value	p-value
Experimental	30	16.80	5.60	9.32	.000
Control	30	5.87	3.15		

The experimental and control groups' academic performance at the application level differed statistically significantly, according to the findings shown in Table 3. The control group, which received instruction using conventional methods, received a significantly lower mean score of 5.87 (SD = 3.15), whereas the experimental group, which was taught using the flipped classroom approach, received a mean score of 16.80 (SD = 5.60). The difference is highly significant, as indicated by the computed t(58) = 9.32 and p value of.000 (p <.05). According to these findings, the flipped classroom strategy significantly outperformed the conventional teaching approach in raising students' academic achievement at the application level.

Table 4: ***Evaluating the Effectiveness of the Flipped Classroom Approach and Traditional Learning Method in Enhancing Students' Overall Academic Achievement***

Group	N	Mean Value	Standard deviation	t-value	p-value
Experimental	30	42.53	7.38	7.83	.000
Control	30	27.30	7.67		

The overall academic achievement of students taught using the flipped classroom approach differed statistically significantly from that of students taught using

traditional methods, according to the results shown in Table 4. The control group received a mean score of 27.30 (SD = 7.67), whereas the experimental group received a mean score of 42.53 (SD = 7.38). This difference is highly significant, as indicated by the computed t(58) = 7.83 and p value of.000 (p <.05). These results show that students' overall academic achievement was significantly improved by the flipped classroom approach compared to the traditional learning method.

Conclusions

According to the study's findings, the flipped classroom strategy had varying effects on academic achievement across various cognitive domains. The experimental and control groups did not differ significantly at the knowledge level, suggesting that the flipped model did not outperform the conventional method in promoting factual recall. However, students taught using the flipped classroom approach outperformed those in the traditional group at the comprehension and application levels, indicating that this pedagogy is effective in encouraging higher-order learning and deeper understanding. Additionally, the flipped classroom approach significantly outperformed traditional teaching, according to the results of overall academic achievement, underscored its potential as a transformative instructional strategy for meaningful learning outcomes.

Discussion

The non-significant knowledge level difference indicates that both teaching strategies are equally successful in fostering lower-order cognitive abilities like factual recognition and memory. This result supports the claim that students' acquisition of foundational knowledge may still be sufficiently supported by traditional teaching approaches, which place an emphasis on memorization and content delivery (Findlay-Thompson & Mombourquette, 2014).

On the other hand, the notable improvements noted at the comprehension and application levels suggest that the flipped classroom offers more chances for critical thinking, active learning, and interactive engagement. These outcomes corroborate those of Bishop and Verleger (2013), who pointed out that flipped instruction frees up class time for group projects, conversations, and problem-solving exercises that promote deeper learning. In a similar vein, Lo and Hew (2017) found that flipped classrooms outperform lecture-based instruction in improving students' conceptual understanding and application skills.

The increase in overall academic achievement is also consistent with the findings of Akçayır and Akçayır (2018), who discovered that flipped classrooms improve learning outcomes and engagement by fusing in-class collaborative learning experiences with self-paced pre-class preparation. Therefore, even though the flipped classroom does not always offer benefits at the level of factual recall, this study adds to the evidence that it is especially helpful in developing higher-order critical thinking skills and knowledge application.

Recommendations

- ✓ Integrate Flipped Pedagogy for Higher-Order Learning: With its demonstrated efficacy in enhancing higher-order learning outcomes, educators ought to embrace the flipped classroom approach, especially in subjects and topics where comprehension, application, and problem-solving are crucial.
- ✓ Combine Conventional and Flipped Methods: A hybrid instructional design may be advantageous, retaining traditional methods for factual recall and utilizing flipped strategies for comprehension and application tasks, as no discernible difference was found at the knowledge level.
- ✓ Teacher Training and Resource Development: To help teachers create engaging pre-class materials (such as readings and videos) and lead interactive in-class learning activities that optimize the advantages of the flipped model, educational institutions should support their professional development and digital resource needs.

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