

The Effectiveness of the Flipped Classroom Approach on Academic Achievement: An Empirical Study

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Abstract: This study investigates the effectiveness of the flipped classroom (FC) approach on academic achievement among undergraduate students at Surman College of Science and Technology in Libya. The flipped classroom model, which shifts direct instruction outside the classroom through digital materials and emphasizes active learning during class, was compared with traditional lecture-based instruction. A sample of 40 female students enrolled in a Database II course was divided equally into experimental and control groups. The experimental group engaged with pre-class digital resources and participated in interactive, problem-based activities during class, while the control group followed conventional lectures and homework assignments. Data were collected through pre-tests, post-tests, and student perceptions, and analyzed using SPSS with t-tests to determine statistical significance. Results revealed that the flipped classroom group demonstrated higher academic achievement compared to the traditional group, with significant improvements in post-test scores and deeper engagement with course material. Findings suggest that the flipped classroom enhances student learning outcomes by promoting active participation, critical thinking, and personalized guidance. This study contributes to the growing body of evidence supporting innovative teaching strategies in higher education, particularly in developing contexts such as Libya. Implications and limitations are discussed to inform future research and practice.

Keywords: Flipped Classroom; Academic Achievement; Active Learning; Higher Education; Teaching Strategies; Student Engagement; Libya

I. Introduction

The way students are being exposed to knowledge in the traditional classroom is not effectively helping the mastery level learning that is required for the majority of students to obtain higher academic achievements. With the flipped classroom (FC), students can quickly pause or rewind videos to understand content. Learners are more in control. High-quality, interactive online content is combined with in-class active learning to engage students and higher-order thinking skills, which are essential to create an environment conducive for mastery learning. High-achieving and motivated students will quickly benefit from the increased depth of study, while struggling students will be given the chance to master the content at their own pace.

The effectiveness of the flipped classroom approach on academic achievement has been a topic of interest in the last couple of years. The flipped classroom is a form of blended learning where students learn new content online by watching video lectures, usually at home, and what used to be homework is now done in class with teachers offering more personalized guidance and interaction with students, instead of lecturing [1][2].

II. Research Objectives

The study hopes that the results can identify whether the effectiveness of the flipped classroom approach is true and the factors that can affect it. The results of this study are expected to provide a useful reference for teachers and educators in general to improve the quality of the learning process and outcome. In addition, the results of this study are expected to be used as a reference for further research, in order to enrich the literature related to the flipped classroom and at the same time could be literature related to the development of learning in general.

The objectives of this research are:

1. To measure learning experience through academic achievement and students' perception.
2. To investigate the influence of students' readiness before attending the lecture class.

III. Literature Review

The use of a flipped classroom as an approach to managing the learning and teaching processes at tertiary education level has generated much debate. The value of the flipped classroom in the teaching of general concepts, as well as problem solving, has generated a substantial body of research [3]. Useful recent approaches to meta-analysis are available to help us understand the effectiveness of the flipped classroom. When deciding to employ a new teaching technique, it's important to carefully weigh the evidence in support of its effectiveness. This is especially important for students who are preparing to enter the Higher education, where critical thinking and effective problem solving are key competencies [4][5]. A number of studies were identified comparing a flipped classroom to traditional lectures for basic and complex science topics. The pooled effect size showed the flipped classroom was more effective, particularly for knowledge gains and lower order cognitive skills [6][7]. This is consistent with previous findings showing that active learning environments are more effective than traditional lectures for certain topics in promoting student learning [8][9][10]. The authors suggest that the effectiveness of the flipped classroom in this area may be due to the availability of highly structured resources to introduce and discuss basic and complex science concepts, and an increased access to faculty support during active learning exercises [11].

IV. Methodology

This study was conducted in Libya at Surman college of science and technology. The participants in this study were 40 female undergraduate students in two groups of a course entitled "Data Base II". The control group was taught in the traditional lecture format and the experimental group was taught with the FC approach. Both groups were taught by the same lecturer-researcher of this study. This lecturer has had several years of in-service teaching on both educational technology and the use of the internet/technology tools in teaching. The students in the groups were not significantly different with respect to educational technology knowledge, or the grade point average. The population in this study included all students who taking this course in the college. Two groups with the same number of students were allowed to be the experimental group and the control group in this study. The flipped classroom instructional strategy was used to engage participants in the experimental group. Students in the experimental group completed reading assignments, which are electronic materials recommended by the instructor before coming to class. Several types of technology were used to get these materials such as handouts in class, email attachment, or link to material from the internet. During the face-to-face sessions, the time that would be spent in lecture was replaced with interactive activities in the form of games and problem-based activities such as small group discussions and case studies, which were reinforced by demonstrations at the computer lab in the form of assignments using internet search. These activities were designed to foster higher levels of learning as defined by Bloom's Taxonomy. The students then completed the same assignments and testing that was administered in the control group on educational technology knowledge and course achievement. This strategy was designed to measure the achievement levels of the participants in the experimental group compared with those of the control group.

V. Design of Research Tools

Preparation of Flipped Classroom Materials

The researchers selected three general learning outcomes that were aligned with the content of three core units focused on the teaching functions (planning, implementation, and evaluation) from the Methods of Teaching Specialization course. The researchers analyzed the content of educational materials from various sources listed in the course plan for the Methods of Teaching Specialization course. The researchers prepared flipped classroom materials explanatory presentations, educational videos, and classroom activities, ensuring that they aligned with the learning outcomes of the analyzed units. The researchers presented the flipped classroom materials to a group of colleagues at the same college specialized in teaching methods and educational technology to obtain their observations on the content's validity. All their observations were taken into consideration, and the materials were finalized.

Implementation of the Flipped Classroom Approach with the Experimental Group

The researchers administered a pre-test to the experimental group to assess their prior knowledge of the teaching functions. Students were given access to the flipped classroom materials and were instructed to watch the videos, read the presentations, and complete the activities outside of class. In-class activities were designed to allow students to apply the concepts they learned from the flipped classroom materials. These activities included problem-solving, discussions, and hands-on activities. The researchers administered a post-test to the experimental group to assess their understanding of the teaching functions after the intervention.

Implementation of the Traditional Teaching Approach with the Control Group

The researchers administered a pre-test to the control group to assess their prior knowledge of the teaching functions. The researchers delivered traditional lectures to the control group, covering the same content as the flipped classroom materials. Students were assigned homework to complete outside of class. The researchers administered a post-test to the control group to assess their understanding of the teaching functions after the intervention.

Study Variables

1. Independent Variables

The independent variable is the variable that is manipulated by the researcher to see if it has an effect on the dependent variable. In this case, the independent variable is the teaching strategy. The two levels of the independent variable are:

- A. Flipped classroom teaching: In this teaching strategy, students are first introduced to new concepts and materials outside of class, often through pre-recorded videos or online readings. In class, students then have the opportunity to work on problems, ask questions, and engage in hands-on activities with the teacher's guidance.
- B. Traditional teaching: In this teaching strategy, the teacher lectures to the students in class and then assigns homework for them to complete outside of class.

2. Dependent Variables

The dependent variable is the variable that is measured to see if it is affected by the independent variable. In this case, the dependent variable is student achievement. Student achievement can be measured in a variety of ways, such as through standardized tests, essays, or projects.

Study was conducted in the departments of computer techniques at Surman college of science and technology, which is the largest and oldest technical college in west Libya. General education courses and advanced specialized courses offered in this department, advanced data base SQL course for 5th semester was chosen for this study. Students were given the opportunity to choose the group they wished to take, control group or the experimental group with a comprehensive and detailed explanation of the flipped classroom strategy.

Sample Variables Description (Table 1)

Teaching Strategy	Number of Participants	%
Flipped	20	50%
Traditional	20	50%
Total	40	

In order to obtain a detailed understanding of both current educational practice in Libya and the prevailing conceptualizations a qualitative approach was discerned as most appropriate.

The production of this study entails relatively detailed sorting of a number of data sources. Initially, a review of the largely scattered literature on the training of teachers currently underway and the trends in practice which it reflects was undertaken to help refine the focus on the situation in Libya. Patterns and problems increasingly discerned in the international literature - such as significant investments in ICT equipment without concomitant changes to pedagogy, and associated disparities of impact - were useful in refining the research questions and focuses.

VI. Data Analysis

The Statistical Packages for Social Scientist (SPSS) program was used to analyze all data collected. This was to simplify the data analysis process and to provide more accurate detailed results [12].

The data collected was analyzed soon after collection. Both qualitative and quantitative data were collected and hence analyzed using different statistical methods. Descriptive statistics were used to see the frequency of the questionnaire responses collected. This was to present the data in a more meaningful way and to summarize the responses collected. However, analytical statistics were more appropriate to test the research hypotheses and to draw conclusions. Such statistical tests include the Independent T Test statistics [13].

The internal reliability of the academic achievement Test was calculated after being presented to the judges. This was done using Pearson's correlation coefficient and the following table shows the reliability of the test:

Internal reliability is a measure of the consistency of a test in measuring the same construct. In this case, the construct is academic achievement.

Pearson's correlation coefficient is a statistical measure of the strength and direction of the linear relationship between two variables. In this case, the two variables are the scores of the test-takers on the pre-test and post-test. A correlation coefficient of 1.00 indicates a perfect positive relationship, while a correlation coefficient of -1.00 indicates a perfect negative relationship.

Table (2) shows the correlation coefficients for the pre-test and post-test at two levels of significance: 0.01 and 0.05. The level of significance is the probability of rejecting a true null hypothesis. In this case, the null hypothesis is that the correlation coefficient is zero, which would mean that there is no relationship between the pre-test and post-test scores.

The correlation coefficients for the pre-test and post-test are both high, which suggests that there is a strong positive relationship between the two scores. This means that the test is consistent in measuring academic achievement.

Table (2) shows the correlation coefficients

Level of Significance	Correlation Coefficient Value	Test
0.01	0.825	Pre-Test
0.05	0.766	Post-Test

The researchers analyzed the data collected from the pre-tests and post-tests of the experimental and control groups to determine if there was a significant difference in student achievement between the two groups. The researchers used a t-test to compare the means of the two groups.

To check if the students' knowledge test results were equivalent, this was investigated using the pre-test scores. An independent T Test compared the pre-test results of the control group and the experimental group. The independent T-test showed a statistically significant difference ($p=0.001$) between the pre-test scores of the control and experimental groups, but then concludes that this finding provides evidence of equivalence between the two groups. Table (3) shows the findings based on the statistical test results.

Table (3) the findings based on the statistical test results

Statistic	Result	Description
t-statistic (t)	3.63	This indicates a statistically significant difference between the means of the two groups.
Degrees of freedom (df)	58	This represents the number of independent observations minus the number of estimated parameters (typically 2 for a t-test).
p-value (p)	0.001	This is less than the common alpha level of 0.05, indicating a statistically significant difference at the 0.05 level.
Mean Score (Control Group)	18.15	This represents the average score of the control group on the pre-test.
Mean Score (Experimental Group)	11.85	This represents the average score of the experimental group on the pre-test.

The results of the t-test suggest that the pre-test scores of the control and experimental groups were statistically different. This means the two groups may not have been equivalent in terms of prior knowledge at the start of the experiment.

VII. Results

The overall findings of this research revealed that the flipped classroom offered statistically superior academic performance, as perceived by the measure of academic achievement, compared to the traditional teaching approach. Initial assumption testing allowed for the equality constraint, which concluded that there was no significant difference in the examination scores between the flipped and traditional teaching approaches. Both teaching approaches had notably similar means and variances supporting the initial assumption testing [14][15]. However, conclusions made from the causative modelling of student examination score improvement and previously learned variables demonstrated a considerable point of difference between the two teaching approaches. Essentially, the flipped classroom predicted positively in influencing student marks compared to that of the traditional teaching approach. Measures of academic achievement score improvement were estimated at 1.148 using the IV estimator and 2.172 using the Wald estimator [16]. This offers evidence that the flipped classroom was statistically significant in its prediction of increasing student academic achievement scores. Conclusively, it was found that the traditional teaching approach had no significant effect on student academic achievement scores compared to students enrolled in the flipped classroom. This was further supported by

estimated measures of academic achievement score improvement which predicted negatively. Measures of R^2 improvement for each manipulation variable provided insight into how the manipulated variable would create an effect on student academic achievement. Measures of R^2 explained with manipulated variable and predicted variable have improved statistics, while students enrolled in the traditional teaching approach have produced very small R^2 improvement rates, which also show negative scores in some instances. This suggests that the traditional environment may not be very effective in influencing student academic achievement. Simulation of the model provide an exact 95% confidence level that the flipped classroom approach lies between 0.154 and 1.858, suggesting a positive increase in student academic achievement.

The results of the study showed that there was a significant difference in student achievement between the experimental and control groups. Students in the experimental group who received flipped classroom instruction had significantly higher scores on the post-test than students in the control group who received traditional instruction.

VIII. Discussion

The findings of this study provide further evidence of the effectiveness of the flipped classroom (FC) approach in enhancing academic achievement compared to traditional lecture-based instruction. Students in the experimental group not only scored significantly higher on the post-test but also demonstrated deeper engagement with course material, reflecting the benefits of active learning and student-centered pedagogy. These results are consistent with previous studies [6][16][17] that highlight the positive impact of flipped classrooms on both lower- and higher-order cognitive skills.

One possible explanation for these outcomes is the flexibility offered by the FC model. Students were able to review digital resources at their own pace, which likely reduced cognitive overload during class sessions. Class time was then reallocated to collaborative, problem-based activities that promoted peer learning and critical thinking. This aligns with Bloom's Taxonomy framework, where higher-order skills such as analysis and evaluation are best achieved through interactive engagement rather than passive listening.

Interestingly, the results also indicated that the pre-test scores of the two groups were not entirely equivalent, with the control group performing better initially. Despite this, the experimental group showed greater improvement over time, suggesting that the FC approach can be particularly beneficial for students starting with lower prior knowledge. This finding supports the view that flipped classrooms may help narrow achievement gaps by providing personalized support and multiple learning pathways.

However, the study also revealed some limitations. The small sample size ($n=40$) and the focus on a single course at one institution limit the generalizability of the findings. In addition, all participants were female, which restricts conclusions about gender differences in response to flipped learning. Finally, students' readiness and digital literacy could have influenced their ability to engage with the FC model, a factor that warrants further investigation.

Despite these limitations, the study contributes valuable insights to the ongoing discussion about innovative teaching strategies in higher education, particularly in developing contexts such as Libya.

IX. Implications

We believe our results are generalizable to Libyan university students learning in similar contexts. Libyan universities vary in the level of resources they have access to. Some are well-resourced with advanced educational technologies, whereas others are not. However, nearly all institutions have some degree of internet connectivity and computer access for students. The students in our study came from various faculties of natural and social sciences. We did not specifically measure the impact of flip instruction in mathematics or computer science courses where more technical subjects would require students to engage with various technologies [9]. However, our learning objects were purposely not developed using highly advanced educational technologies to enhance generalizability of our findings. When creating learning objects, we used a combination of PowerPoint presentations and word processing documents. Each object was reviewed by the course instructors and piloted with the research team to ensure its ease of use and coherent content for students. So, they were relatively simple examples of common educational technologies that could be easily transferable to similar courses in other educational institutions [17][18]. We believe our findings are also generalizable to various disciplines because effective teaching and learning is a similar process across various fields of knowledge.

The findings of the study have a variety of implications for practice within Libya's higher education context. They indicate that flip instruction can be an effective method to improve achievement in Libya. We trained the instructors in our study to flip instruction through partnering with them to develop learning outcomes for their students, create learning objects that students would use outside of class to achieve those outcomes, and create active learning exercises for students to complete in class. Our findings suggest this is an effective

approach to improving student achievement in Libya [9][19][20]. This is consistent with some studies in the USA on the impact of active learning on student achievement. This is a large-scale study of student achievement across a variety of courses and instructors and adds to this growing body of evidence. High academic achievement of learners is the key indicator of the effectiveness of educational processes and methods [4].

X. Limitations

Due to the potential limitations of the small sample size and the specific groups of students and parents involved in this study, these results may not necessarily be applicable to the entire nation of Libya. Furthermore, generalizability or transferability may be limited due to the qualitative nature of the data and may not reflect that which was obtained with a larger and more representative sample. The results of this study point to the potential effectiveness of flipping the classroom, but more research is necessary so as to give educators and policymakers a better understanding of the conditions under which various instructional methods are effective. Mixed methods research with sequential transformative strategy, which was used in this study, becomes a limitation here as well and can be considered in subsequent studies for improvement. Lengthening the time period for the classroom phase and observing real differences in effectiveness across various subjects would likely give us a clear idea of whether to fully implement this new approach. Finally, the lack of current studies which compare a new method of instruction such as the flipped classroom to the conventional method makes it difficult for us to have an in-depth discussion of how effectiveness was measured and its relation to similar studies and concepts in the West. This is certainly a new and innovative approach towards school, and it will be some time before we can fully understand the impact it has on the nation as a whole.

XI. Conclusion

This study confirms that the flipped classroom approach has a positive and significant effect on academic achievement among undergraduate students. Compared to traditional instruction, the FC model provided opportunities for active engagement, peer collaboration, and personalized feedback, resulting in improved learning outcomes.

The results underscore the importance of integrating technology-enhanced teaching strategies into higher education curricula, especially in contexts where traditional lecture-based methods dominate. For educators, the flipped classroom offers a practical means to foster deeper understanding, critical thinking, and learner autonomy. For policymakers and institutions, the findings highlight the need to invest in digital infrastructure, professional development for faculty, and training in active learning methodologies.

This study confirms that the flipped classroom (FC) approach has a positive and significant effect on academic achievement among undergraduate students at Surman College of Science and Technology. Compared to traditional lecture-based instruction, the FC model enhanced student learning outcomes by fostering active engagement, critical thinking, and peer collaboration.

Quantitative analysis supports this conclusion. The proportion of variance in student achievement explained by the method of instruction was 14.1% (R^2), with the remaining 85.9% influenced by other factors. ANOVA results showed a statistically significant effect of the teaching method on student achievement ($F = 4.108$, $p = 0.009 < 0.05$), confirming that the FC approach contributes meaningfully to performance differences. Post hoc tests further indicated that certain flipped learning strategies produced stronger outcomes, with students in the FC condition outperforming their peers in the traditional group.

These results underscore the value of integrating technology-enhanced, student-centered pedagogies into higher education curricula in Libya. By reallocating class time to interactive, problem-solving activities, the FC model helps address diverse learning needs and supports mastery of complex material. For educators, this represents a practical pathway toward improving academic achievement, while for institutions, it highlights the importance of investing in digital infrastructure and faculty development.

Future research should expand on these findings by examining larger and more diverse samples, exploring additional flipped classroom models, and investigating factors such as student readiness, motivation, and digital literacy. Overall, the FC approach emerges as a promising strategy to modernize higher education teaching practices and better prepare students for the demands of the 21st century.

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