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Investigating the Use of Flipped Classroom Technologies on Students' Learning at Secondary Level

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Abstract: *The flipped classroom concept, considered a crucial element of blended learning, has garnered significant attention from scholars and educators in contemporary times. The flipped classroom concept entails a pedagogical approach where the traditional sequence of classroom activities and homework assignments is inverted. This study provides an overview of flipped classroom technology and examines its potential benefits for educators and learners. The authors report the findings from deploying the flipped classroom approach in the language learning environment. The research demonstrates that using the aforementioned technology within the educational process raises students' motivation and promotes their academic performance.*

Key Words: Flipped Classroom Technologies, Students, Secondary Level, Blended Learning, Education

Introduction

The use of technology in education, namely through the revolutionary flipped classroom approach, has attracted significant interest due to its capacity to transform conventional teaching and learning methodologies. This research investigates the effects of flipped classroom technologies on students at the secondary level. This instructional paradigm promotes active learning by enabling students to participate in lessons at their own individualized speed (Salom, 2023). Additionally, it supports personalized instruction by using pre-class assessments. Through an examination of the experiences of students and teachers who have used these technologies, the research seeks to provide valuable insights into academic accomplishment, student engagement, and overall learning experiences (Karaca & Ocak, 2017).

Additionally, the research emphasizes the potential of the flipped classroom approach to augment student motivation, self-regulation, and language proficiency (Strayer, 2016). The study conducted by (Heijerman et al., 2019) acknowledges both positive outcomes, such as enhanced academic achievement, and obstacles related to integrating technology and organizational issues. It is suggested that further investigation be conducted to successfully tackle these problems and promote the incorporation of flipped classroom technology in education (Kazeminia et al., 2022).

Significance of the Study

This study has substantial significance as it aims to reveal the benefits and obstacles associated with using flipped classroom technology in the context of secondary education. The comprehension of the effects of these technologies on students' learning outcomes can be a significant asset for educational policymakers, administrators, and teachers (McDonald & Smith, 2013). This research analyses the merits and limitations of flipped classroom techniques, offering decision-makers valuable insights for designing instructional tactics.

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Moreover, this study expands its contribution to the broader domain of education by providing valuable insights into the efficacy of flipped classroom technologies in promoting active learning, delivering individualized instruction, and improving overall academic achievement (Arslan, 2020). The findings of this study possess the capacity to impact educational methodologies, encouraging adjustments that align with the dynamic nature of technology-integrated learning.

The results obtained from this study have the potential to influence the adoption and utilization of flipped classroom technologies significantly. The study supports efforts to improve student involvement, foster deeper comprehension, and establish a more efficient learning atmosphere in secondary education, as indicated by previous research conducted by (Kanuka & Garrison, 2004)and (Kim et al., 2006). Engaging in this activity makes a valuable contribution to the current reservoir of knowledge in the field of education. This study has practical implications for educators and policymakers that aim to enhance teaching approaches to maximize the educational outcomes of secondary-level pupils.

Problem Statement

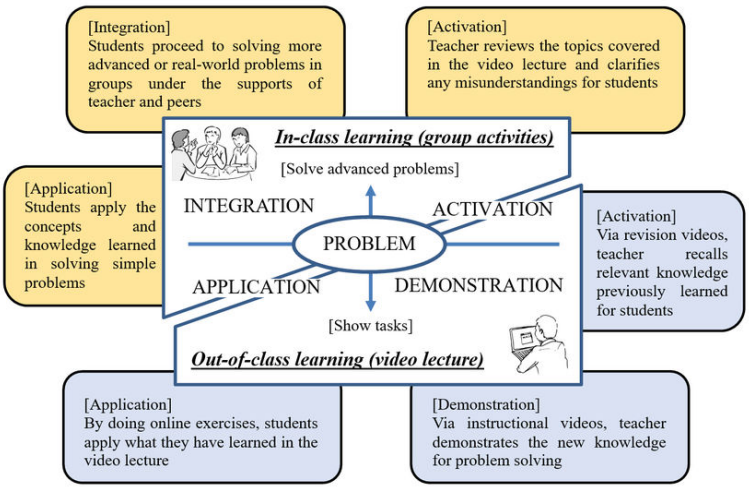
The problem statement for this study highlights the urgent necessity to examine the utilization of flipped classroom technologies and their consequences on students' learning in the secondary education context. Despite the growing prevalence of flipped classroom models, there is a notable deficiency in the existing body of literature, as there is a scarcity of comprehensive research investigating their efficacy and influence on academic performance, student engagement, and broader educational outcomes in secondary education (Han, 2015). The lack of comprehensive investigation into the experiences and viewpoints of students and teachers who have utilized these technologies contributes to the widening of this gap, impeding a nuanced comprehension of the distinct advantages and challenges specific to the secondary education setting (Kelly). The primary objective of this work is to fill the existing knowledge gaps by a comprehensive investigation, making a substantial contribution to the current research literature. In this endeavor, the aim is to provide educators, policymakers, and administrators with valuable insights that will assist them in making well-informed decisions about the incorporation of flipped classroom technology within secondary-level educational settings (Smith et al., 2021).

Conceptual Framework

The conceptual framework for examining the impact of flipped classroom technology at the secondary level is intricately designed around three core elements underpinned by seminal educational theories. First and foremost, the framework emphasizes the systematic integration of flipped classroom technologies, such as online materials and video lectures, ensuring a comprehensive exploration of factors influencing their effectiveness. This includes an examination of technology accessibility, teacher expertise in implementing these technologies, and the alignment of flipped strategies with the existing curriculum (Lee & Kim, 2020).

Figure 1

Frame work of flipped classroom



Furthermore, the framework gives due consideration to the paramount importance of student engagement and interaction in the flipped classroom environment. It seeks to understand the dynamics of how students interact with pre-recorded materials outside the traditional classroom setting, their participation during in-class exercises, and their active engagement with teachers to seek clarifications or additional guidance (Herreid & Schiller, 2013). This component emphasizes variables such as student motivation, active engagement quality, and collaborative teamwork effectiveness (Tucker, 2012).

Ultimately, the conceptual framework extends its purview to encompass an assessment of the broader educational outcomes of implementing flipped classroom technologies. This includes an examination of scholastic achievements, the cultivation of critical thinking abilities, and the acquisition of a deep comprehension of the subject matter. The evaluative approach incorporates quantitative measures, such as standardized test scores, and qualitative indicators, including insights from student perspectives through interviews or surveys (Saichaie, 2020).

The comprehensive nature of this framework is anchored in educational theories, specifically drawing from constructivism and technology-enhanced learning theories. Constructivism (Jonassen, 1991) provides a lens through which to understand how students actively construct knowledge in a flipped learning environment, while technology-enhanced learning theories (Siemens, 2005) offer insights into integrating technological tools to enhance the learning experience. This theoretical foundation enriches the framework, enabling a nuanced analysis of the potential impact of flipped classrooms on students' learning experiences and outcomes in the context of secondary education.

Research Objectives

1. To assess the impact of flipped classroom technologies on students' academic achievement at the secondary level.
2. To provide recommendations for the effective integration of flipped classroom technologies into secondary-level education based on the findings of the study.

Research Questions

1. How does the use of flipped classroom technologies impact students' academic achievement compared to traditional classroom methods at the secondary level?
2. What recommendations can be made for educational institutions, policymakers, and educators on the appropriate use and pedagogical approaches of flipped classroom technologies to enhance student learning outcomes at the secondary level?

Literature Review

The concept of flipped classroom learning, which involves students engaging with digital content outside of class and actively participating in collaborative activities during class time, has gained significant attention in the field of education. Numerous studies have explored the benefits and challenges associated with implementing this student-centered approach. Flipped classroom learning has been found to enhance student engagement and motivation, promote active learning and critical thinking skills, and allow for personalized and differentiated instruction. However, challenges related to technology access, teacher training, and assessment methods have been identified. Empirical evidence suggests that flipped classroom learning positively influences student learning outcomes, including academic performance, knowledge retention, and attitudes toward learning. Successful implementation of this model is dependent on factors such as effective planning, the use of engaging and interactive content, and the establishment of a supportive and collaborative classroom environment. However, criticisms and limitations, such as potential workload increases and access issues, have been raised. Further research is needed to explore the long-term effects of flipped classroom learning, adapt the model to diverse educational settings, and investigate the integration of emerging technologies. In contrast to the conventional instructor-centered, lecture-based instructional approach, the flipped classroom model offers a more interactive and advanced learning experience during in-class sessions. In this model, lectures are typically delivered online before class, allowing students to access and review them at their convenience and as frequently as desired. This shift in instructional design has been supported by scholars such as (Long, Cummins, et al., 2019). The

flipped classroom model can be distinguished from the previous blended learning model due to its incorporation of two distinct types of learning, which are organized into two separate learning periods (EKİNCİ et al.). The initial stage of the instructional process is referred to as the pre-class individual learning phase. In this phase, students receive educational materials in many media formats, including videos and text. This approach has been discussed by scholars such as (Cabero Almenara et al., 2021). The subsequent stage entails in-class interactive learning, during which students engage in a range of interactive learning activities, including question-and-answer sessions, the elucidation of advanced concepts, discussions, problem-solving exercises, and collaborative projects (Long et al., 2020). Implementing the flipped classroom model results in a shift from a passive to an active learning approach for students (Choi et al., 2018). During the pre-class learning phase, students can control the rate at which they engage in learning activities (Sun et al., 2018). The utilization of interactive learning activities within the classroom not only grants students a heightened level of accountability for their educational development but also necessitates more intricate cognitive processes and reasoning abilities (Zainuddin et al., 2019). The activities above have the potential to effectively include students in cognitive processes that need higher-order thinking skills and problem-solving abilities (Kim et al., 2018).

According to (Mohamed & Lamia, 2018), implementing the flipped classroom learning approach can potentially enhance students' problem-solving skills, collaboration skills, conflict management capacity, time management abilities, and team-building capabilities. In addition, the flipped classroom offers a high degree of flexibility, allowing instructors in different disciplines and settings to choose, combine, and utilize a diverse array of technical approaches and learning activity designs (Long, Zhiyan et al., 2019).

The Flipped Classroom Model (FCM) is a developing educational framework that seeks to enhance students' engagement in the learning process by promoting active learning, collaboration, and scaffolding. This is achieved by optimizing the allocation of teaching time (Bergmann & Sams, 2012). The FCM, in particular, proposes that the percentage of teaching time during in-person school sessions should prioritize providing distinctive learning opportunities through collaborative activities among students, supplemented by guidance from the teacher, rather than relying on teacher lectures (Morehead et al., 2016). To achieve this objective, the utilization of digital technologies such as learning environments (e.g., Learning Management Systems) and educational resources (e.g., educational videos and online quizzes) can be employed to actively involve students in independent study and self-evaluation before in-person classroom sessions (Chen et al., 2014). In this manner, teachers' instructional delivery can be substituted by these educational resources, hence allowing for the reallocation of classroom time towards the facilitation of captivating learning experiences.

The FCM has garnered considerable interest from practitioners and researchers across various subject domains, such as Mathematics (Sergis et al., 2018), Social Studies (Aidinopoulou & Sampson, 2017), and Humanities (Grossman et al., 2016). Most previous studies have focused on examining the effects of FCM on a specific range of factors, namely students' cognitive learning results and general motivation (Lo & Hew, 2017).

Several examples can be cited to illustrate the findings of (Andrikopoulos & Kostaris, 2017) regarding the influence of the Flipped Classroom Model (FCM) in the context of ICT studies at the Junior High school level. The study provided novel insights into the effects of FCM on enhancing students' cognitive learning outcomes and overall motivation. These effects were significantly more pronounced when compared to a control group that participated in a traditional, non-flipped course. Additionally, the study presented intriguing results indicating that pupils with low academic performance demonstrated the most significant advancements in their educational achievements. According to (De los Reyes Lozano, 2017), using Fuzzy Cognitive Maps (FCM) in a K-12 Mathematics course enhanced students' cognitive learning outcomes. This finding is supported by (Bhagat et al., 2016), who also observed a beneficial impact on students' motivation.

Furthermore, a study conducted by (Katsa et al., 2016) revealed that students who were exposed to a high school Mathematics course enriched with FCM improved their cognitive learning outcomes and motivation levels. Further examination of the enhancement in students' performance revealed that the most significant group of improvement was observed among students who initially had low academic performance. In the realm of Humanities, (2015) conducted a study that demonstrated the substantial

positive impact of the FCM on students' cognitive learning outcomes and motivation. This was assessed by measuring their level of effort and attitudes towards the learning process. According to (Chen & Hong, 2016), there was a considerable improvement in students' English reading comprehension due to the learning intervention that used FCM techniques.

In recent years, there has been a notable increase in research studies that have specifically examined the effects of FC learning environments on students' academic results. One such study, conducted by (Zengin, 2017), is particularly noteworthy. The learning environment in this study was constructed by incorporating the FC Model in conjunction with Khan Academy and freely available open-source software (Zengin, 2017). This study aimed to examine the FC Model's effects on students' academic performance and ascertain their perspectives on this model (Zengin, 2017). The study consisted of 28 students enrolled in the Mathematics Teaching Program at a state university in Turkey. The study's findings indicated that the FC learning environment, which incorporated both Khan Academy and mathematics software, resulted in a twofold increase in the students' academic achievement (Zengin, 2017). Furthermore, it has been discovered that this instructional methodology enhanced student learning, promoted visual aids in mathematics instruction, and contributed to long-lasting retention of knowledge (Zengin, 2017).

The study conducted by Zhonggen and Wang (2016) aimed to examine the efficacy of the FC Model in enhancing English writing courses through the utilization of mixed methods research. The study's results were gathered using a satisfaction scale, a Business English writing test, and a structured interview (Zhonggen & Wang, 2016). The researchers conducted a scale of satisfaction and Business English writing test as both pre- and post-tests (Zhonggen & Wang, 2016). According to Zhonggen and Wang (2016), the results indicated that participants in the experimental group, who received instruction using the FC Model, achieved higher scores on the scales specified before compared to participants in the control group, who were taught in a conventional learning setting.

Research Methodology

This study adopted an experimental research design to investigate the use of flipped classroom technologies on students' learning at the secondary level. The research design involved a pretest-posttest control group design, where participants were randomly assigned to either the experimental group, which utilized flipped classroom technologies, or the control group, which followed traditional classroom methods. The study was conducted over a period of ten weeks.

Participants

The participants of this study were students from two secondary schools. One school was randomly assigned as the experimental group (n=40), while the other school served as the control group (n=40). The participants were selected using stratified random sampling to ensure diversity in terms of gender, grade level, and academic performance.

Intervention

The experimental group underwent a flipped classroom intervention, where instructional content was delivered through online videos, interactive online platforms, and other digital resources. Students were required to watch the instructional videos and complete related assignments and quizzes before attending class. The control group received traditional face-to-face instruction during regular classroom sessions.

Flipped Classroom Activities

Here are some flipped classroom activities. By incorporating these activities into a flipped classroom model, students can actively engage with the content, collaborate with their peers, and develop a deeper understanding of the subject matter. The flipped classroom approach allows for more interactive and application-based learning experiences during class time, enhancing student engagement and fostering critical thinking skills.

1. Pre-class video presentations: Create pre-recorded video presentations on key concepts or topics. Assign these videos as homework for students to watch before coming to class. This allows them to

grasp the basic content independently and come prepared to engage in deeper discussions and activities during class time.

2. Online Discussions: Use online discussion forums or platforms to facilitate discussion among students. Assign thought-provoking questions or prompts related to the pre-class content and encourage students to respond and engage in meaningful dialogue with their peers. This fosters critical thinking and collaborative learning.
3. Case Studies and Problem-solving Activities: Assign real-life case studies or problem-solving activities as pre-class assignments. Students can analyze the cases or solve the problems independently at home and then collaborate in class to discuss their approaches, share insights, and brainstorm solutions.
4. Hands-on Experiments or Simulations: Provide access to virtual labs or simulations for students to explore scientific principles, conduct experiments, or engage in interactive simulations outside of class. In class, students can discuss their findings, compare results, and address any questions or uncertainties arising from their experiments.
5. Project-based Learning: Assign project-based tasks that require students to engage with the content, conduct research, and apply their knowledge to solve real-world problems. Students can work on their projects independently at home and then present their findings or deliverables in class, allowing for peer feedback and collaboration.
6. Flipped Worksheets or Quizzes: Create worksheets or quizzes that students complete independently before class to assess their understanding of the pre-class materials. In class, review the answers together, clarify any misconceptions, and engage in deeper discussions to reinforce understanding and address any lingering questions.
7. Collaborative Group Activities: Use class time for collaborative group activities such as debates, role-plays, problem-solving tasks, or group presentations. These activities promote teamwork, critical thinking, and the application of knowledge gained through pre-class learning.

Data Collection

To assess the impact of flipped classroom technologies on students' learning outcomes, a pretest and posttest were administered to both groups. The pretest was conducted prior to the intervention to establish a baseline measurement of participants' knowledge and skills. The posttest was administered at the conclusion of the ten-week intervention to evaluate the learning outcomes of both groups. The tests consisted of multiple-choice questions and open-ended questions designed to assess the student's understanding and application of key concepts.

Validity and Reliability

To ensure the validity of the pretest and posttest instruments, a panel of experts in the field of education and content-specific experts reviewed the tests to assess their alignment with the learning objectives and the reliability of the questions. Additionally, a pilot study was conducted with a small sample of students to evaluate the clarity and appropriateness of the questions. Based on the feedback received, necessary revisions were made to improve the validity and reliability of the tests. The reliability of the test was measured through SPSS v-28. It was measured as 0.78, which is considered good by the experts.

Data Analysis

By employing this experimental research design and rigorous data collection and analysis methods, this study aimed to provide valuable insights into the impact of flipped classroom technologies on students' learning outcomes at the secondary level. The findings of this study can inform educational policymakers, administrators, and teachers in making evidence-based decisions regarding the integration of flipped classroom technologies in secondary-level classrooms.

Table 1

Pre-test (control & experimental group)

	Groups	N	Mean	SD	T	Sig.
Pre-Test	Control	20	11.62	3.16	0.074	0.95
	Experimental	20	11.56	2.93		

The pre-test results indicate comparable mean scores between the Control group (M = 11.62, SD = 3.16) and the Experimental group (M = 11.56, SD = 2.93) with a negligible difference of 0.074 in the t-statistic. The sample sizes for both groups were equal (N = 20). The p-value associated with the t-statistic is 0.95, surpassing the conventional significance level of 0.05, suggesting that the observed difference in means is not statistically significant. Consequently, based on the pre-test data, there is no substantial evidence to reject the null hypothesis, implying that, at this stage, the two groups do not significantly differ in their scores.

Table 2

Post-test (control & experimental group)

	Groups	N	Mean	SD	T	Sig.
Post-Test	Control	20	24.95	2.30	6.8	0.38
	Experimental	20	28.43	1.56		

The post-test results reveal notable differences between the Control and Experimental groups. In the Control group, the mean score substantially increased to 24.95 (SD = 2.30) from the pre-test, while the Experimental group exhibited a higher mean of 28.43 (SD = 1.56). The t-statistic of 6.8 suggests a significant difference in post-test scores between the groups. However, the p-value of 0.38 exceeds the common significance level of 0.05, indicating that the observed difference is not statistically significant. Despite the high t-statistic reflecting a substantial change, the lack of statistical significance suggests caution in concluding a true group difference. Further investigation or a larger sample size might be needed to confirm the practical significance of the observed changes in post-test scores between the Control and Experimental groups.

Findings

The findings of this study indicated that the use of flipped classroom technologies had a significant impact on students' learning outcomes at the secondary level.

Firstly, there was a statistically significant improvement in the post-test scores of the experimental group compared to the control group. This suggests that students who participated in the flipped classroom intervention achieved higher levels of knowledge and skill acquisition compared to those in the traditional classroom group.

Secondly, the experimental group showed higher levels of engagement and motivation towards learning. Students reported a greater sense of ownership and responsibility for their learning, as they were actively involved in watching instructional videos, completing assignments, and participating in interactive online platforms.

Thirdly, the personalized instruction offered through pre-class assessments and tailored instruction in the flipped classroom environment was found to be effective in addressing individual student needs. Students reported that they appreciated the ability to revisit instructional materials, clarify their doubts, and seek additional support at their own pace.

Conclusion

In conclusion, the findings of this study support the effectiveness of flipped classroom technologies in improving student's learning outcomes and engagement at the secondary level. The use of online videos, interactive platforms, and digital resources as pre-class materials enhanced students' understanding and retention of content, enabling them to actively participate in meaningful classroom discussions and activities.

The findings also highlight the importance of providing personalized and individualized instruction to cater to the diverse needs of students. Through pre-class assessments and tailored instruction, teachers can adapt their teaching strategies to address the specific learning needs and preferences of each student, resulting in a more personalized and effective learning experience.

The subject in question has been undervalued or underestimated. They are incorporating the flipped classroom model into the educational framework results in a heightened level of student motivation and interest in acquiring foreign languages. Moreover, it benefits students' self-discipline and self-directedness as a result of them assuming accountability for their educational pursuits. Using flipped classroom technology presents significant pedagogical opportunities for educators and learners. Despite the declining prevalence of in-person classrooms, the educational process remains unaffected in quality.

Furthermore, the survey findings indicated a noticeable enhancement in pupils' academic achievement. Nevertheless, many technological and organizational obstacles hinder the incorporation of flipped classroom technology into the teaching and learning process. Further study is required to address these problems and develop a novel educational setting centered around implementing the flipped classroom technology.

These findings have implications for both educators and policymakers. Educators can consider incorporating flipped classroom technologies into their instructional practices to enhance student engagement and promote active learning. Policymakers can support the integration and professional development of teachers in utilizing flipped classroom technologies by providing necessary resources and training.

It is important to note that this study had limitations, including the generalizability of findings to a specific geographical area and the relatively short duration of the intervention. Future research could explore the long-term effects of flipped classroom technologies and examine their impact across various subject areas and student populations.

Overall, the findings of this study provide valuable insights and support the growing body of literature on the effectiveness of flipped classroom technologies in secondary-level education. By embracing innovative pedagogical approaches like flipped classrooms, educators can better meet the diverse learning needs of students and create a more engaging and interactive learning environment.

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